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AN EXPERIMENTAL ANALYSIS OF PUBLIC GOODS PROVISION MECHANISMS WITH AND WITHOUT UNANIMITY

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ABSTRACT

The paper reports on an experimental investigation of four methods of allocating public goods. The two basic processes studied are direct contribution and a public goods auction process. Both of these processes are studied with and without an additional unanimity feature. The results suggest that the auction process outperforms direct contribution. The effect of unanimity is to decrease the efficiency of both processes. Much of the paper is focused on an analysis of these results.

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I. INTRODUCTION

The experiments reported below are one small part of a much larger and more complex research effort. A detailed explanation of the context would be completely out of place, but a brief description will help the reader understand the design and our priorities in reporting results.

The United States National Aeronautics and Space Administration (NASA) has prepared to launch a manned space station, which is to become operational by 1994. Because the station will have low gravitational fields and an absence of atmosphere, the facility can be used for a variety of purposes ranging from basic research to manufacturing. The experiments reported below are part of a task that involves designing a method for the government to choose among all of the competing uses. Much sentiment exists within the government (NASA) to rely as heavily as is possible upon market processes. The task that motivates the research is to determine what form such reliance might take.

The observation that sets the stage for our narrow research questions is that the space station will have many features characteristic of public utilities. Ideas and suggestions about alternatives to public utility pricing lead naturally to questions about decentralized methods of covering common costs and to subsequent questions about decentralized methods for solving the public goods provision problem.

Several theoretical solutions to the public goods problem exist in the literature. (See Groves and Ledyard, 1985, for a review.) Our operating assumption has been that a mechanism that reliably solves public goods problems can be adapted to solve common cost problems. Unfortunately, very little is known about the behavioral properties of such mechanisms. Most of them have been subjected to no experimentation at all. The most promising mechanism, based on the existing experimental evidence, is a mechanism designed by Vernon Smith (1979a,b; 1980). Even though the theoretical aspects of the Smith process are not fully understood, the previous experimental evidence is that the mechanism can be used to solve public goods problems with a high degree of reliability and efficiency. If the Smith process or some variation of it is indeed a reliable method of solving the public goods problem, then it or a suitable modification of it might serve as a foundation for solving common cost aspects of space station pricing problems. Theory suggests this possibility and Smith's previous experiments are corroborative.

The research strategy reported in this paper was to investigate the reliability of the Smith process under the most difficult parametric conditions (economic environment) that have been reported in the literature.

For some unknown reason certain public goods environments are "easy" in the sense that several processes manage to generate near optimal amounts of the public good while other environments are difficult in the sense that tested processes generate near zero levels. Our strategy was to first test the proposed processes within a difficult environment. If the performance was satisfactory, the research strategy was to then perform additional experiments in other environments thought to be similarly difficult and/or related to environments that might actually exist for space stations. Naturally data and theories that might lead to improved processes would be analyzed along the way. The overall task envisages many different types of experiments and simulations and not just one. This paper reports on the first step.

The most difficult environment explored to date was developed by Isaac, McCue, and Plott (1985). A direct contribution process that has worked reasonably well in other environments, (Smith 1979b), was shown to lead to near zero levels of public good provision. If the Smith process or some slight variation performed well in this environment, the stage would be set for further development and experiments with the Smith process.

As will be outlined below, two variations of the Smith process were studied: one with a unanimity provision and one without the

unanimity provision. As a control a direct contribution mechanism with unanimity and without unanimity was also studied. The economic environment was the one developed by Isaac, McCue, and Plott.

Initial expectations based on previous experiments were that the Smith process with unanimity would produce decisions near 100 percent levels of efficiency. It was further suspected that removal of the unanimity provision would cause substantial reductions in efficiency. Both expectations were proven incorrect. After presenting those central results that were relevant to the initial purposes of the experiment, section V continues by presenting ex post analysis of the reasons for the unexpected results. The section concludes with some analysis of choices and strategies at the individual level of analysis.

II. THE DECISION MECHANISMS AND PARAMETERS

The experimental task presented the subject was to collectively provide a public good using one of the four mechanisms to be described below. Each subject was given a payoff function expressing personal reward from various levels of the public good, q, before any payments for the provisions of the good. Two functional forms were used.

$$U_H'(q) = 44 - 1.1q \quad \text{(in cents)} \qquad \text{(high payoff)}$$

or

$$U_L'(q) = 27.6 - 0.8q \quad \text{(in cents)} \qquad \text{(low payoff)}$$

thereby yielding two types of agents. Instead of the actual functional form the subjects were given the discrete approximations given in Figures 1 and 2. There were five agents of each type. In all the Smith process experiments the experimental medium was francs in that all bids were in francs while all but one of the direct contribution experiments used cents. Each individual was privately given a personal dollar/franc conversion rate.

Since the variable q is common to all payoffs, it is a public good. Subjects were told that the good would be provided at a constant marginal cost of 130 cents per unit. The task was to use the decision mechanisms to choose both a quantity and an allocation of the common cost among themselves. As shown on Figure 2 the optimal quantity is any amount in the interval (23,24].

The decision was not made only once. The process of deciding, paying, and being paid was called a period. Each experiment consisted of several periods. Thus, decisions were replicated several times by each group so that the effects of replication and/or experience could be assessed.

Four different mechanisms were used. The basic mechanisms were either direct contribution or the Smith process. Each was studied with and without a unanimity feature.

<u>Direct Contribution without Unanimity</u> (<u>DC</u>). At the beginning of a period each agent being fully aware of his/her private payoff function, chose a level of personal contribution b_i. These decisions were privately transmitted (slips of paper) to the experimenter who computed $\sum_{i=1}^{10} b_i$. The quantity, $\sum_{i=1}^{10} b_i/130¢ = \hat{q}$, was then calculated and

announced. Each individual then calculated $U^i(\hat{q}) - b_i = \pi_i$, where $U^i(q)$ is the payoff function for i and b_i is the contribution of i. The amount, π_i, was the profit for individual i during that period which was his/hers to keep. In brief, the individual's contributions are collected and were all used to purchase units of the public good. The return to the individual for that period was the value of the public good provided minus the contribution.

<u>Direct Contribution with Unanimity</u> (<u>DCU</u>). Each period of the process consisted of a series of up to five trials (the first period had ten trials). The direct contribution process was used as described above up to the calculation of π_i. After calculating π_i a vote was taken. If it was unanimously affirmative, each agent was paid π_i and the mechanism proceeded to the next period. If one or more no votes were registered, then no payments were made and a new "trial" was initiated in which agents could tender new bids. If no unanimous agreement was attained after five trials, no payment was made for that period and the next period was started.

<u>Smith Process without Unanimity</u> (<u>SP</u>). Each period consisted of a series of trials. At the beginning of a trial each agent chose a 2-tuple (b_i, q_i), which was privately transmitted to the experimenter. The quantities, $\sum_{i=1}^{10} b_i$ and $1/10 \sum_{i=1}^{10} q_i = \bar{q}$ were computed. If $\sum_{i=1}^{10} b_i \geq 130¢$, then the profit for each agent, i, was $\pi_i = U^i(\bar{q}) - b_i\bar{q}$, $i = 1,\ldots,10$. If $\sum b_i > 130¢$, each agent received a rebate of the

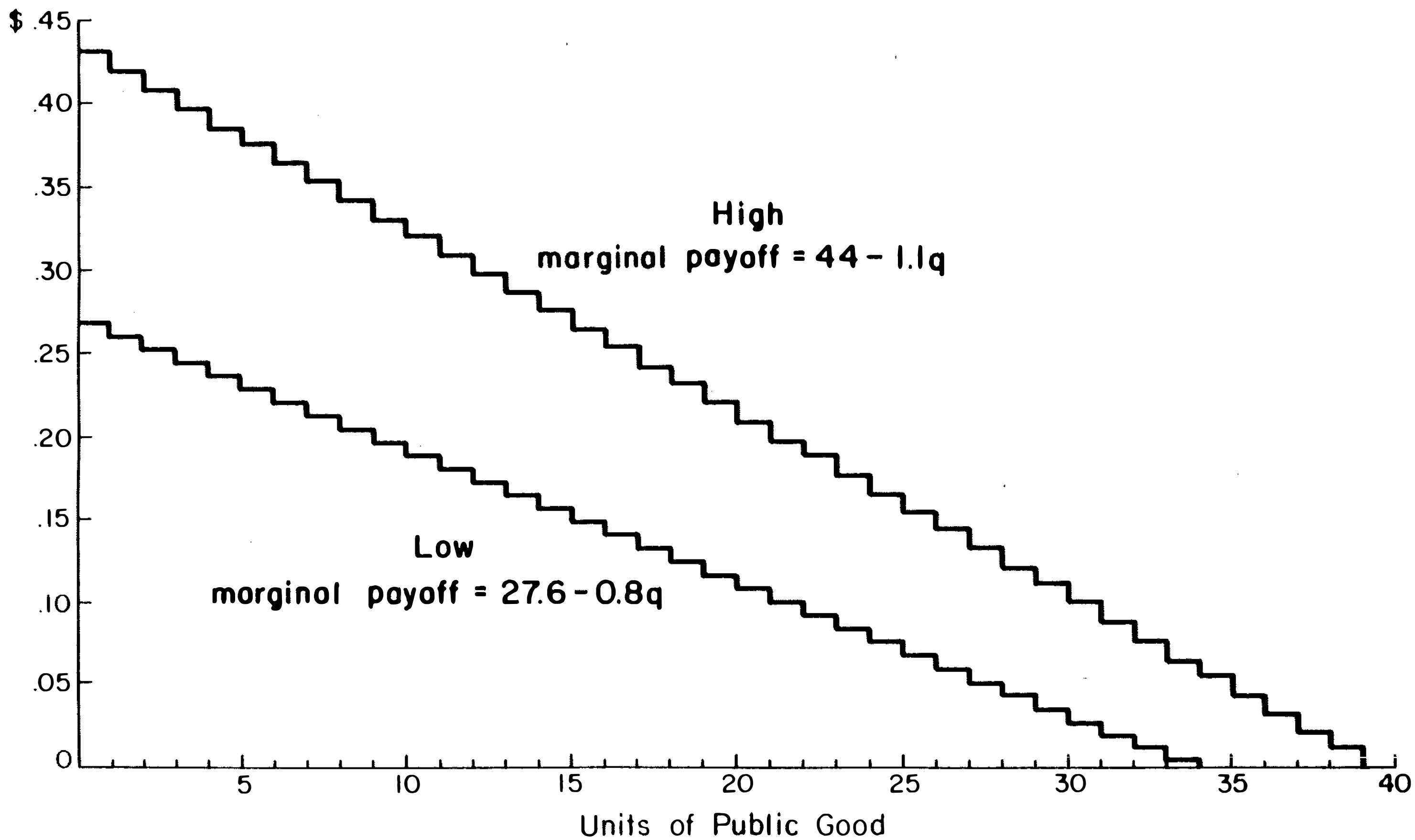


FIGURE 1 Derived Demand Curves for High and Low Payoffs

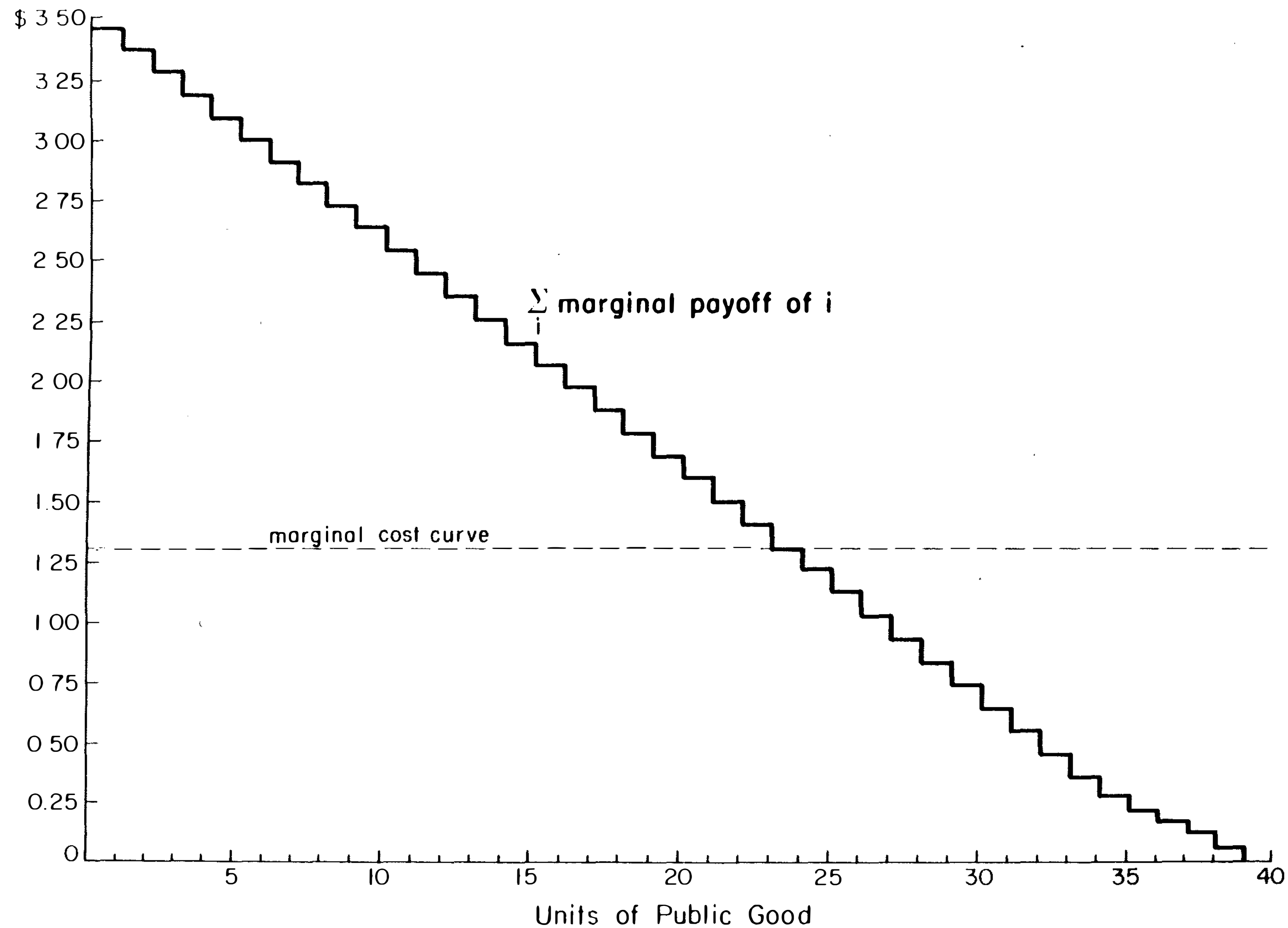


FIGURE 2 Market Demand and Marginal Cost Curve

excess.[1] With $\bar{q}$ decided and each person paid, the period was ended, and the experiment moved to the first trial of the next period. If $\sum b_i < 130¢$, then the provision level was 0 on that trial. The mechanism then moved to the next trial in which new choices could be made. If no trial of the five permissible resulted in $\sum b_i \geq 130¢$, the period ended with zero payment to all and a new period was initiated.

Smith Process with Unanimity (SPU). The process was identical to SP except that a vote was taken if $\sum_I b_i \geq 130¢$. That is, if $\sum_I b_i \geq$ cost, then $\bar{q}$ was announced so individual profits could be calculated and then a vote was taken. If the decision was unanimously accepted, then each agent received the profit (positive or negative). If the vote was not unanimous, then the provision level was zero, no payments were made, and the next trial began. Except for the first period all periods had a maximum of five trials.

Two features of the procedures/process are worthy of special note. First, in SP and in DC where real possibilities of losses existed, subjects were given five dollars working capital at the beginning of the experiment. The failure to provide this working capital in the two cases where unanimity operated was a design error that forces us to include the capital payment along with unanimity itself as a treatment variable. Of course theoretically the capital payment should make no difference since it was a lump sum grant at the beginning of the experiment and subjects were never in a situation in which they needed to speculate on whether or not the experimenter

would (or could) take money from them.

A second feature involves a restricted message space. Bids could never be negative, i.e., $b_i \in [0,\infty)$. This feature differs from Smith (1979a) but not Smith (1979b, 1980). In the Smith processes the messages about quantities were restricted to tenths and $q_i \in [0,\bar{q}_i]$ where[2]

$$\bar{q}_i = \begin{cases} 40 \text{ if } i \text{ is in high group} \\ 34 \text{ if } i \text{ is in low group} \end{cases}$$

Smith's research (1979a,b 1980) led to broad conclusions relevant to the research reported here.

(1) In periods in which an agreement was obtained, the Smith process (SPU) results in quantity levels of the public good that do not differ significantly from the theoretical Lindahl optimum.

(2) Final bids submitted by participants were not demand revealing (Smith 1979b, 1980). However, Smith (1979a) found support for demand-revealing (Lindahl bids) behavior.

(3) The direct contribution process with unanimity generated levels of public good choices that were not significantly different from those generated by SPU.

The situation studied here differs from that studied by Smith in several potentially important ways. Any of these could account for the differences with Smith that we report.

(1) Smith used different payoff parameters. His utility functions permitted income effects while ours are additive.

(2) The difference between the free-rider and Lindahl quantities was less in in Smith. His free-rider quantity was three units and the Lindahl quantity was nine. Ours were zero and twenty-three respectively.

(3) Smith's experiments primarily involved only one choice for which the groups were paid but some of his groups were asked to participate in a second period. Our experiments involved several repetitions of three to nine periods.

(4) The Smith (1979a) method of putting the unanimity process into operation was different from ours. For the Smith process the Smith experiments had all subjects report the same level of the public good twice and the same (cost covering) bid twice. In ours a vote was taken whenever cost was covered. Our method of implementing unanimity is the same as in Smith (1979b, 1980).

III. MODELS

The primary research questions focus upon the reliability of the Smith process to produce efficient choices and the influences of unanimity. These questions are not motivated by theory so much as by experiences with the operation of the mechanism and by the overriding problem of finding a mechanism that "works reliably." Theory and models do have a role in providing an understanding of why the

mechanisms perform as they do and in suggesting modifications. In this section some of the relevant models are outlined.

The Lindahl optimum or Lindahl equilibrium concept has played a special role in the public goods literature so it is a natural concept to explore. Briefly, a Lindahl equilibrium in a public goods environment is a quantity q^* of the public good and a vector of prices $(p_1,\ldots,p_n)$ such that the marginal benefit to each individual of q^* is equal to his price. Given the specific parameter values above, the Lindahl equilibrium quantity in the experiments is in the interval $(23,24]$, with prices

$$p_i = \begin{cases} 17.6¢ & \text{if } i \in \text{high demand group} \\ 8.4¢ & \text{if } i \in \text{low demand group.} \end{cases}$$

The Lindahl equilibrium concept is sometimes thought to be a normative criterion. Game-theoretic equilibrium analysis generates predictions on what might happen given the strategic possibilities of the individuals, where an (arguably) appropriate model is that of Nash equilibrium or any of its possible refinements. One question we can then ask is whether any of the mechanisms discussed above implement the Lindahl equilibrium via Nash equilibrium behavior; that is, does there exist a Nash equilibrium to the game generated from the mechanism which supports the Lindahl equilibrium as a solution?

In what follows we characterize only the equilibria in the static, "one-shot" games, leaving aside the equilibria of the supergames derived from the use of repeated trials in the determination of outcomes. Furthermore, we will look at only the perfect Nash equilibria (Selten 1975).

Let m_i be the message individual i sends, where m_i consists of a bid (b_i) and quantity (q_i) for SP and SPU, and simply a bid for DC and DCU, and let $m = (m_1,\ldots,m_n)$. Each vector m implies a vector of profits $\pi(m) = (\pi_1(m),\ldots,\pi_n(m))$ for the individuals determined by the mechanism in use. For SPU and DCU we will denote these as interim profits. Given the sequential nature of decision-making in SPU and DCU (i.e., sending messages, receiving data, and then proceeding to vote), a strategy for individual i will consist of a message m_i and a vote function $v_i(\cdot)$ where without loss of generality we can let $v_i(\cdot)$ be a function of i's interim profits.

The elimination of weakly dominated strategies inherent in the perfectness criterion implies that, in a perfect Nash equilibrium of SPU or DCU $v^*(\cdot) = (v_1^*(\cdot),\ldots,v_n(\cdot))$ must satisfy, for all i,

$$v_i^*(\cdot) = \begin{cases} \text{vote yes} & \text{if } \pi_i(m) \geq 0 \\ \text{vote no} & \text{if } \pi_i(m) \leq 0. \end{cases}$$

(If $\pi_i(m) = 0$, i is indifferent between voting yes and no.) Thus, in a perfect Nash equilibrium, individual i cannot threaten to vote no if his interim profits are positive; this threat, which is allowable under the Nash equilibrium concept, is a consequence of voting strategies such as

$$v_i(\cdot) = \begin{cases} \text{vote yes} & \text{if } \pi_i(m) \geq \bar{\pi}_i \\ \text{vote no} & \text{if } \pi_i(m) \leq \bar{\pi}_i, \end{cases}$$

where $\bar{\pi}_i > 0$ is the equilibrium interim profit of i. Thus, any quantity level q can be supported by Nash equilibrium behavior if there exists a vector of bids $b = (b_1,\ldots,b_n)$ such that all individuals earn non-negative profits.

Define $b_{-i} = (b_1,\ldots,b_{i-1},b_{i+1},\ldots,b_n)$, and similarly for q_{-i}. The (pure strategy) perfect Nash equilibrium predictions for the mechanisms are as follows:

<u>SP</u>: (b^*,q^*) is a perfect Nash equilibrium if[3]

i) $\sum_i b_i^* = 130¢$, $1/n \sum_i q_i^* \in [23,24)$, and

$$b_i^* = \begin{cases} 17.6¢ & \text{if } i \in \text{high demand group} \\ 8.4¢ & \text{if } i \in \text{low demand group} \end{cases}$$

ii) $\sum_i b_i^* < 130¢$, and $\forall i$,

$$\max_{q_i} \pi_i(b_{-i}^*, 130¢ - \sum_{j\neq i} b_j^*, q_{-i}^*, q_i) < 0.$$

Thus, if the mechanism is SP and if costs are covered, then the (interior) perfect Nash equilibria support the Lindahl optimal outcome as an equilibrium.

<u>SPU</u>: $(b^*,q^*,v^*(\cdot))$ is a perfect Nash equilibrium if i) or ii) holds, and

iii) $\forall i$, $v_i^*(\cdot) = \begin{cases} \text{vote yes} & \text{if } \pi_i(b,q) \geq 0 \\ \text{vote no} & \text{if } \pi_i(b,q) \leq 0. \end{cases}$

Since, at the Lindahl optimum all individuals earn positive profits, both SP and SPU implement the Lindahl optimum as perfect Nash equilibrium behavior.

DC: (b^*) is a perfect Nash equilibrium if

iv) $b_i^* = 0, \quad \forall i.$

Thus, the only perfect Nash equilibrium in DC is the "free-riding" equilibrium.

DCU: $(b^*, v^*(\cdot))$ is a perfect Nash equilibrium if iii) holds (replacing $m = (b,q)$ with $m = (b)$) and

v) $|\{i \in I : \pi_i(b^*) = 0\}| \geq 2,$ and
$v_i^*(b^*) = \text{yes}, \quad \forall i;$

or

vi) $\exists\ j$ s.t. $v_j^*(b^*) = \text{no},$ and
$\forall i,\ \forall b_i'$ s.t. $[v_k^*(b_{-i}^*, b_i') = \text{yes}, \forall k \neq i],$
$\pi_i(b_{-i}^*, b_i') < 0.$

Thus, for DCU there exist perfect Nash equilibrium outcomes with positive quantities of the public good. However, in these equilibria at least two individuals must be making zero profits because if only one person is making zero profits that person should lower the bid. If there is no allocation then it must be the case that no individual can (profitably) change his/her bid and induce others to bid yes. Hence, neither DC nor DCU implements the Lindahl optimum via perfect

Nash equilibrium behavior.

IV. EXPERIMENTAL DESIGN

Subjects were recruited from Pasadena City College (PCC) and California Institute of Technology (CIT). They were asked to participate in an economics experiment for which they would be paid. Each experiment consisted of ten subjects and lasted for about two hours. The exact instructions read to the subjects are included as Appendix A.

A total of twenty-four experiments were conducted. Six experiments were conducted under each of three treatment variables (DCU, SP, SPU). The six experiments with DC are those that were reported in Isaac, McCue, and Plott (1985).[4] The experiments with relevant parameters are in Table 1.

V. EXPERIMENTAL RESULTS

The time series from all trials of all experiments are in Figures 3, 4, 5, 6. The results relative to the questions that motivated the experiments are reviewed in the first subsection. The subsections following the first deal substantially with questions that arose after the experiments were conducted and the data analysis had been initiated. The second subsection involves inquiries about the accuracy of models of the processes. The third subsection elaborates an observation that the tradeoff exists among performance variables of primary interest. The overall performance of the process is analyzed in terms of success and failure. The final section is devoted to

TABLE 1

EXPERIMENTAL PARAMETERS

Experiment	Subject Pool	Number of Subjects per Payoff Group: High	Number of Subjects per Payoff Group: Low	Optimal Quantity	Lindahl Contribution: High(¢)	Lindahl Contribution: Low(¢)
Direct Contribution with Unanimity[b]						
1	PCC	5	5	(23,24]	17.6	8.4
2	PCC	5	5	(23,24]	17.6	8.4
3	PCC	5	5	(23,24]	17.6	8.4
4	CIT	5	5	(23,24]	17.6	8.4
5	PCC	5	5	(23,24]	17.6	8.4
6	CIT	5	5	(23,24]	17.6	8.4
Direct Contribution without Unanimity[a]						
1	CIT	5	5	(23,24]	17.6	8.4
2	CIT	5	5	(23,24]	17.6	8.4
3	PCC	5	5	(23,24]	17.6	8.4
4	CIT	5	5	(23,24]	17.6	8.4
5	PCC	5	5	(23,24]	17.6	8.4
6	CIT	5	5	(23,24]	17.6	8.4
Smith Process with Unanimity						
1	CIT	5	5	(23,24]	17.6	8.4
2	CIT	5	5	(23,24]	17.6	8.4
3	CIT	5	5	(23,24]	17.6	8.4
4	PCC	5	5	(23,24]	17.6	8.4
5	PCC	5	5	(23,24]	17.6	8.4
6	CIT	5	5	(23,24]	17.6	8.4
Smith Process without Unanimity						
1	CIT	5	5	(23,24]	17.6	8.4
2	CIT	5	5	(23,24]	17.6	8.4
3	PCC	5	5	(23,24]	17.6	8.4
4	PCC	5	5	(23,24]	17.6	8.4
5	PCC	5	5	(23,24]	17.6	8.4
6	CIT	5	5	(23,24]	17.6	8.4

a. The information in this table is taken from Isaac, McCue, and Plott (1985).
b. Values were represented in francs in experiment 1 and in cents in experiments 2-5.

FIGURE 3A SMITH PROCESS WITH UNANIMITY

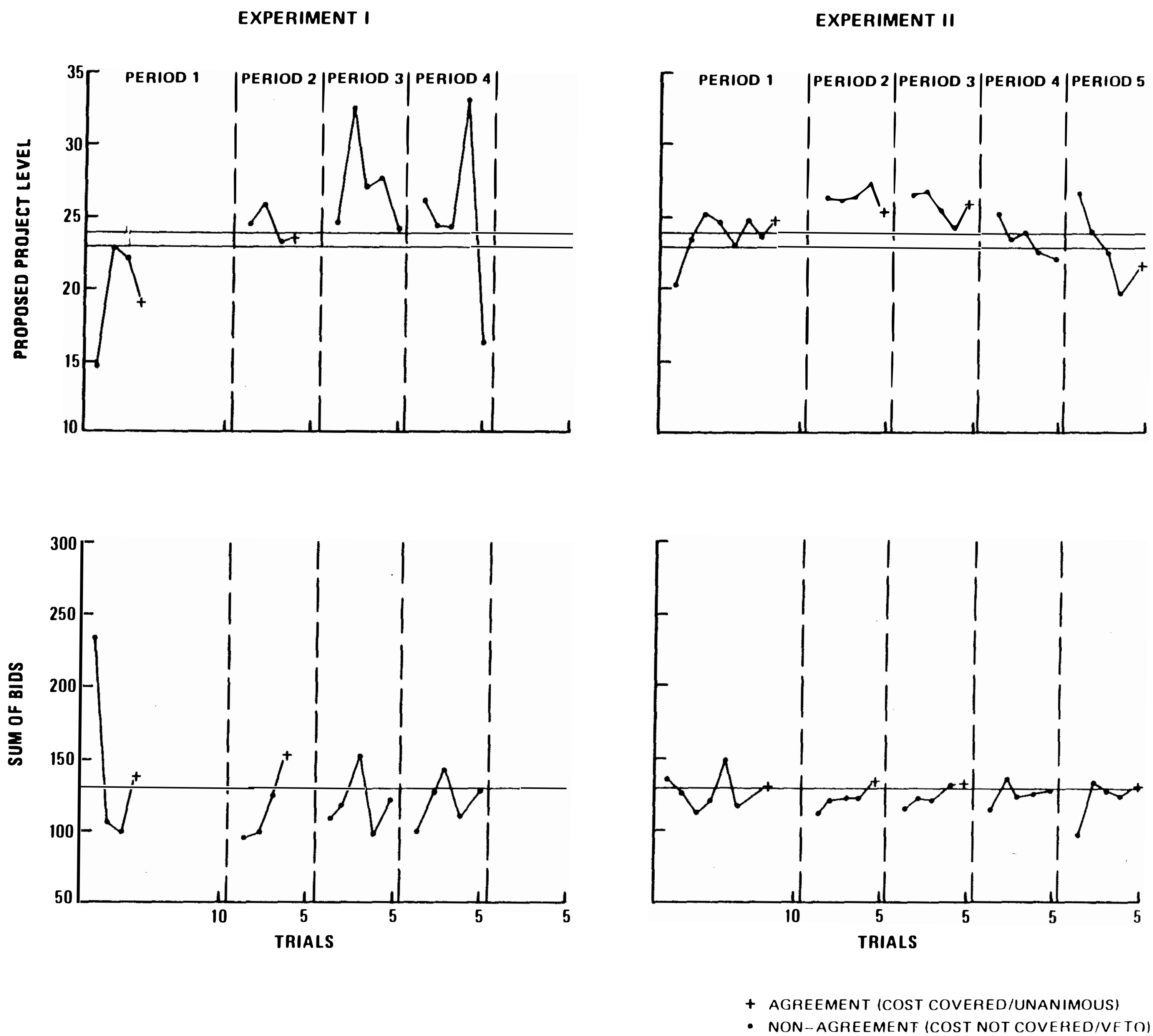


FIGURE 3B SMITH PROCESS WITH UNANIMITY

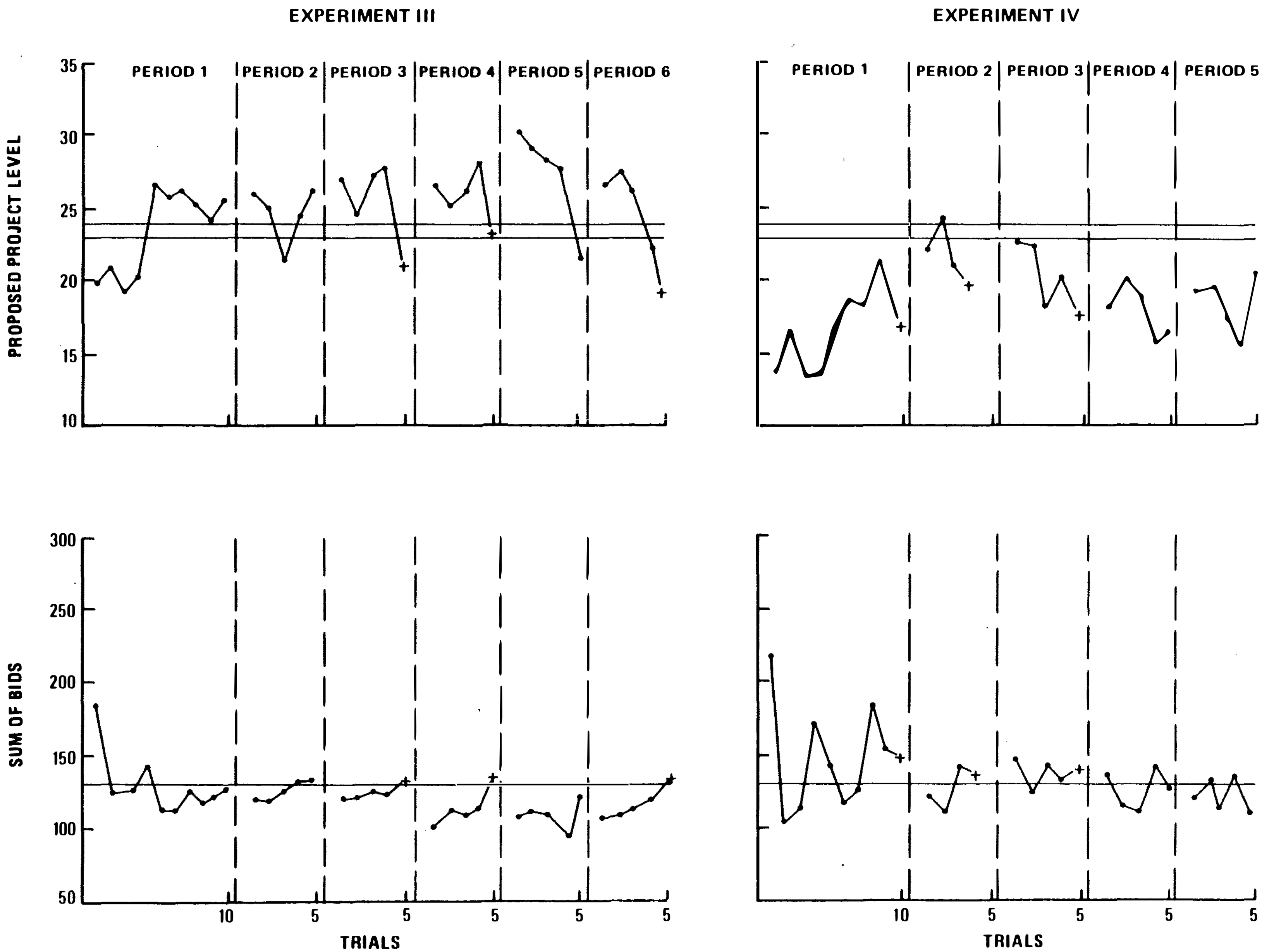


FIGURE 3C SMITH PROCESS WTIH UNANIMITY

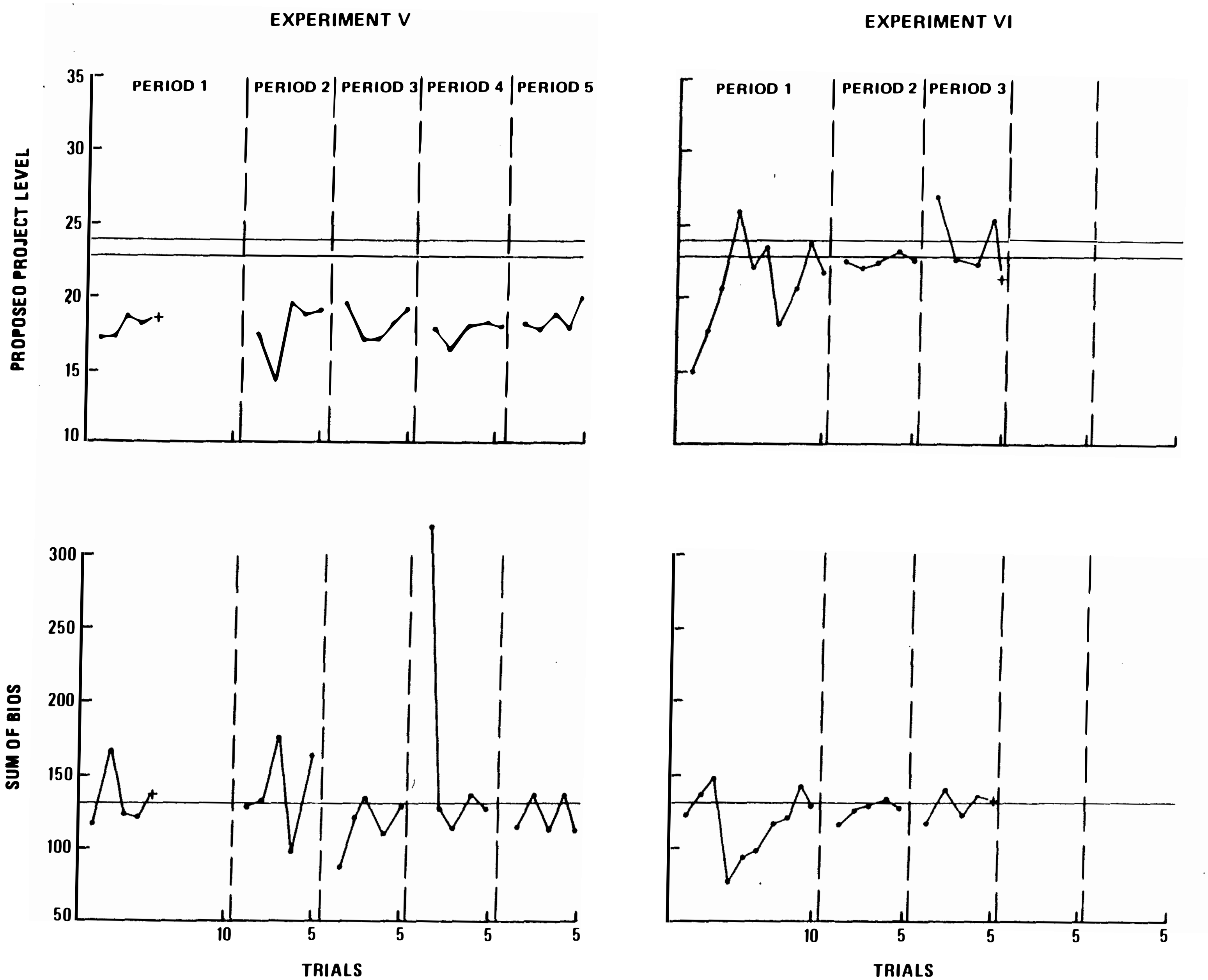
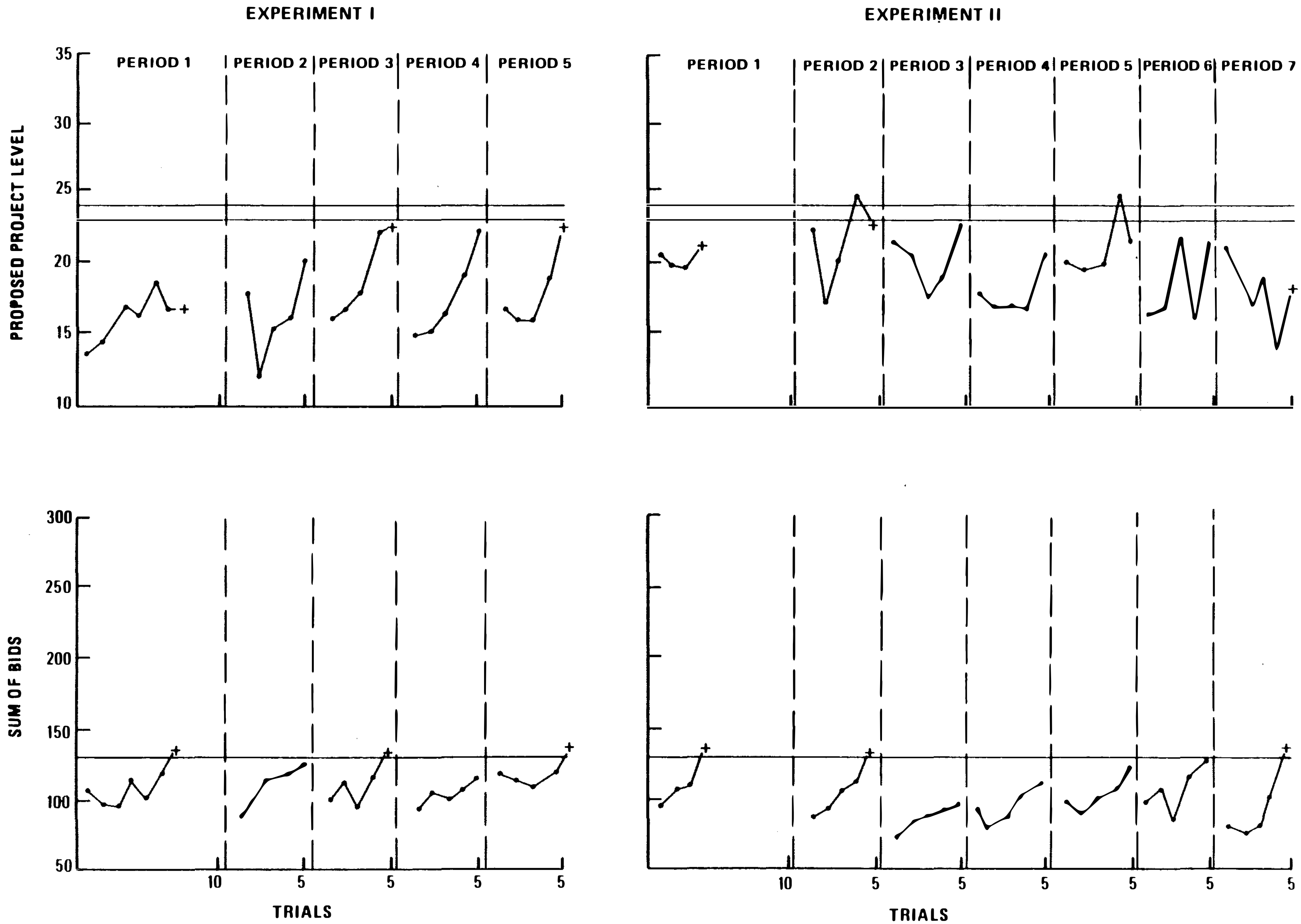


FIGURE 4A SMITH PROCESS WITHOUT UNANIMITY



+ AGREEMENT (COST COVERED)

• NON AGREEMENT (COST NOT COVERED)

FIGURE 4B SMITH PROCESS WITHOUT UNANIMITY

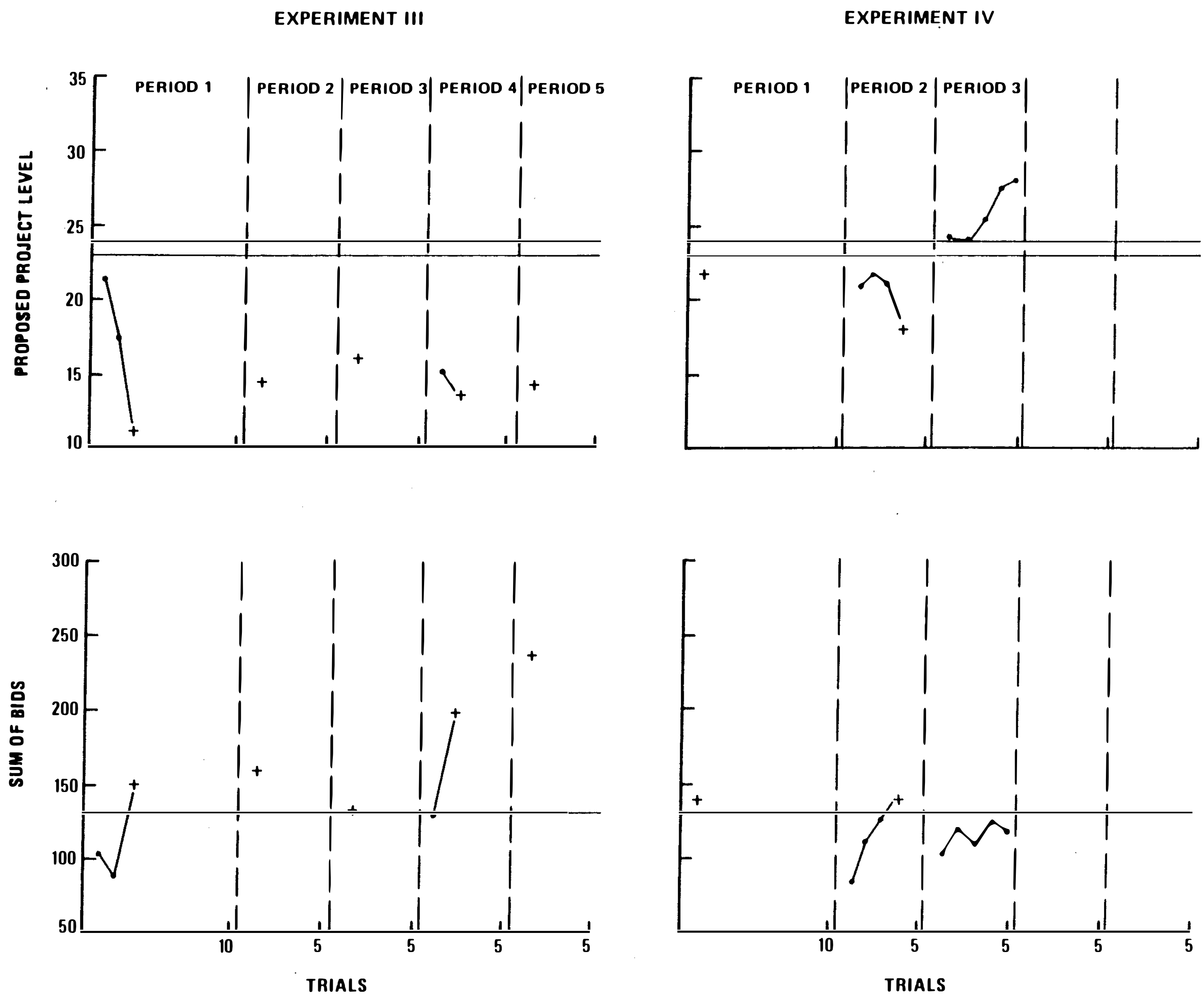


FIGURE 4C SMITH PROCESS WITHOUT UNANIMITY

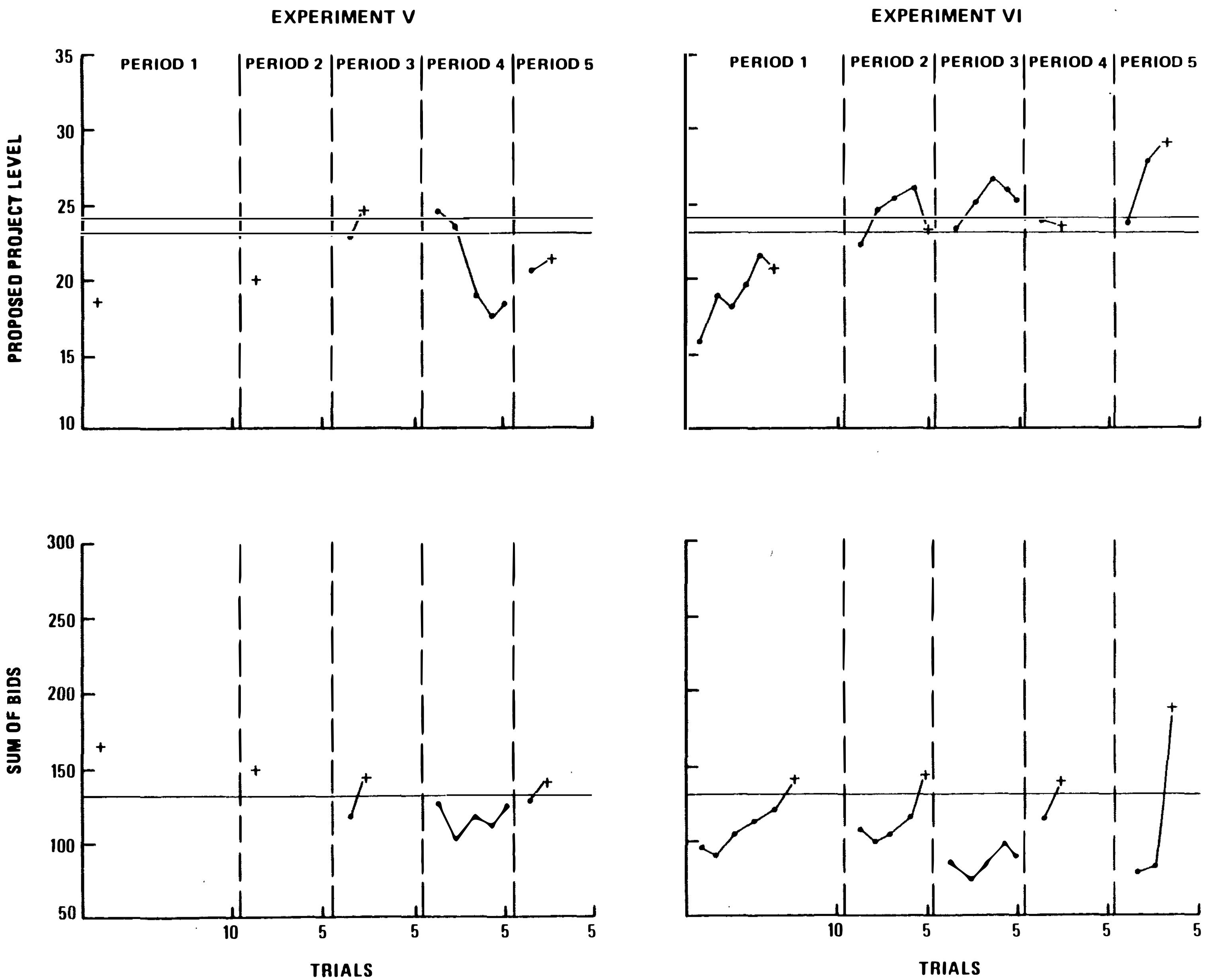


FIGURE 5 DIRECT CONTRIBUTION WITH UNANIMITY

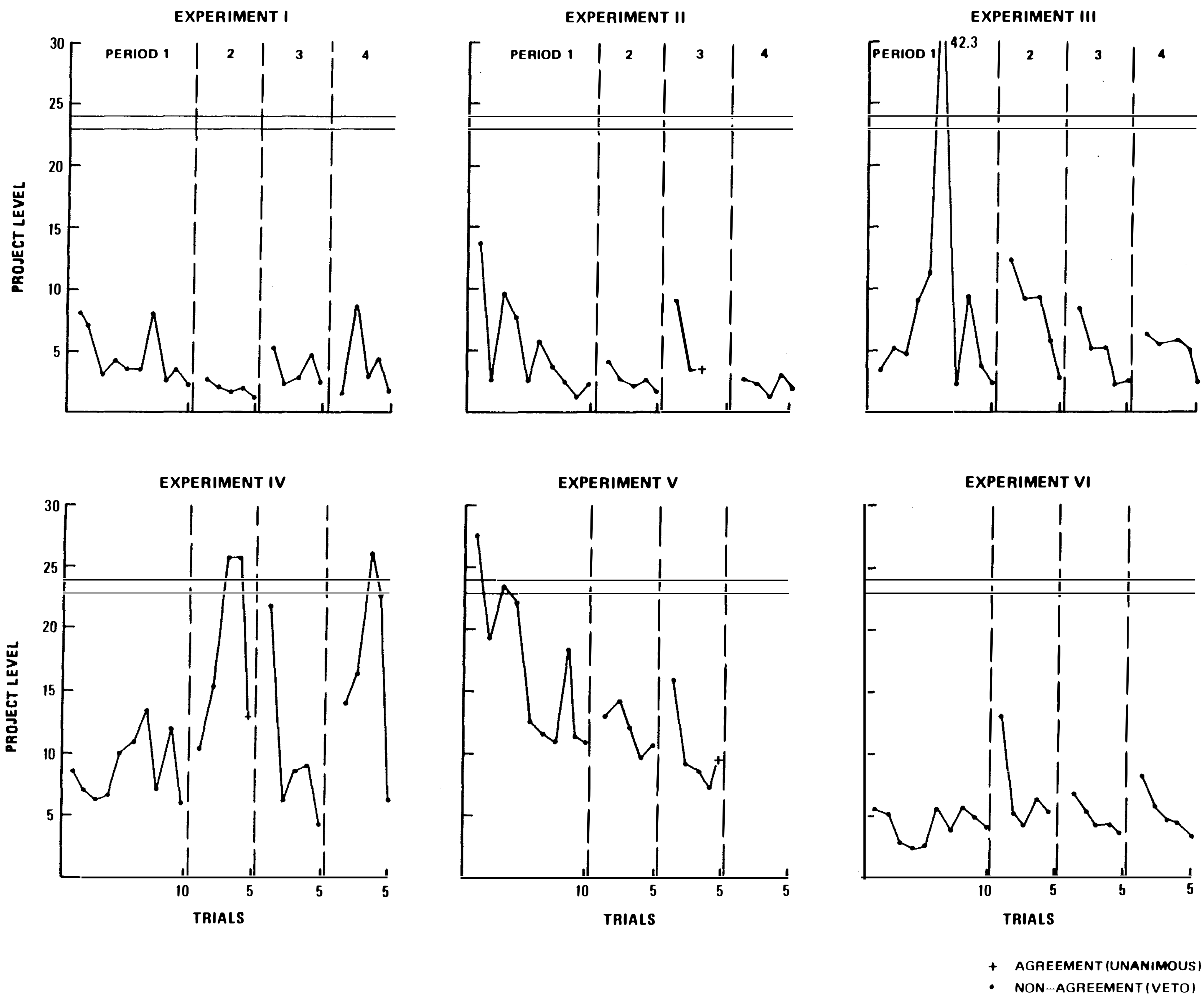
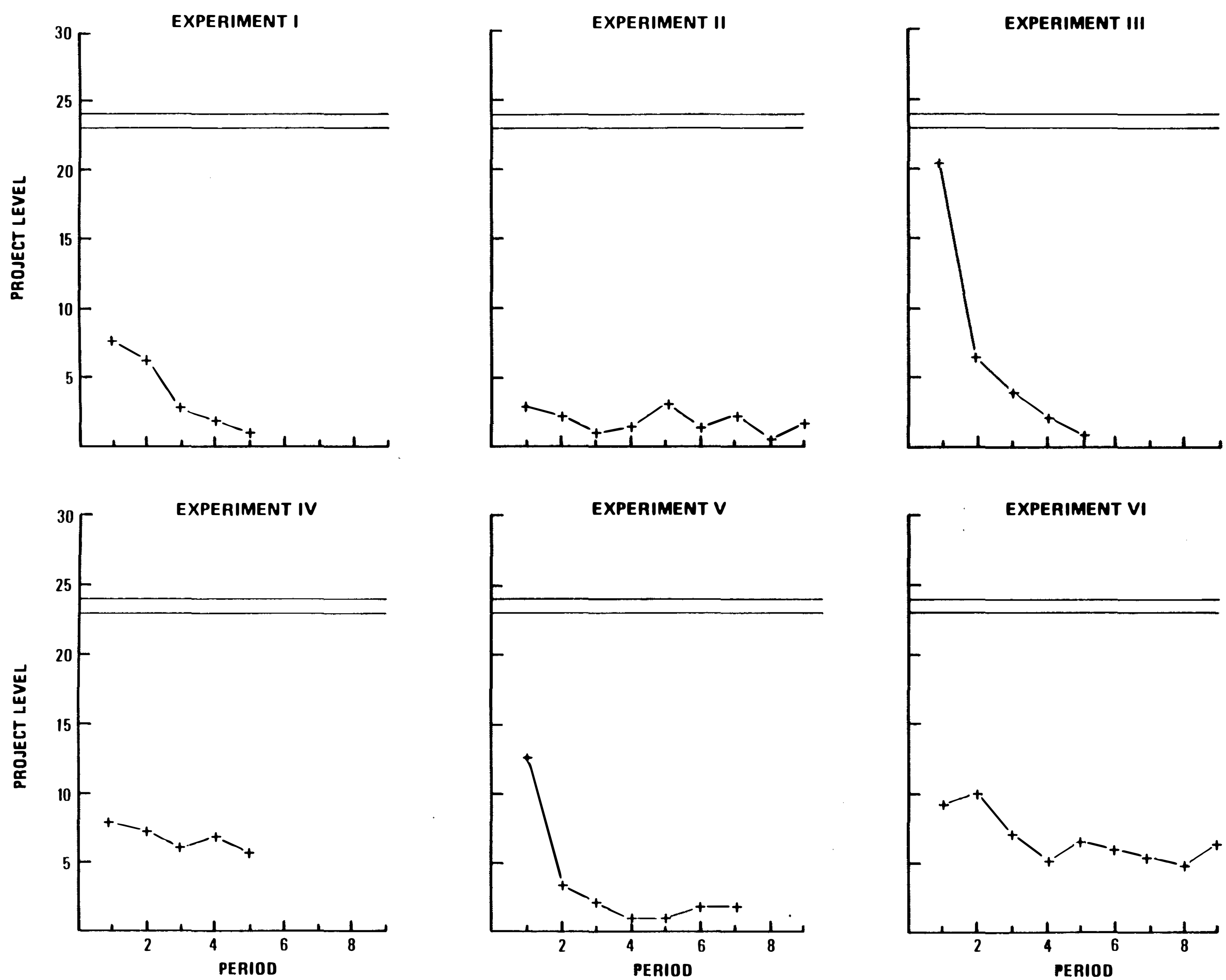


FIGURE 6 DIRECT CONTRIBUTION WITHOUT UNANIMITY



isolating manifestations of strategic uses of unanimity.

The main results from the experiments can be categorized in the box in Table 2 that shows the overall provision levels. The statistical analysis of the elements of Table 2 will be based primarily on distribution-free statistics. Specifically, we will employ the Wilcoxon Rank Sum Test (see Lehmann, 1975) unless otherwise stated. We use this nonparametric test since:

(a) most of the distributions tend to be multimodal and skewed;

(b) we have no reason to suspect normality of the underlying distributions;

(c) most of our tests are two sample problems in which equality of the two distributions are tested.

Before we present our conclusions we point out that the data used in the statistical analysis are at times pooled over trials or periods of the experiments. Since the data in any one experiment are sequential, the assumption of independence in these cases does not likely hold. Thus, while the Wilcoxon Rank Sum Test is in general robust it does require independence.

To read Table 3 the mechanisms listed in the table column are assumed to generate samples with a cumulative distribution F(z), and the mechanisms listed in the table row are assumed to generate samples with a cumulative distribution G(z). The z-scores listed in the table are derived from testing the hypothesis

$$H_0 : F(z) = G(z) \qquad \forall z$$

against

$$H_a : F(z) > G(z) \qquad \forall z$$

1. <u>Overall Performance of Mechanisms</u>

<u>Conclusion 1</u>. The Smith process generates project levels that are more efficient than the direct contribution mechanisms.

<u>Support</u>. Notice first in Table 2 that with or without unanimity the Smith process has higher levels of provision and higher efficiency levels than does the DC or DCU processes. If all periods are considered, then from Table 3 we find that the SP levels are significantly higher than DC or DCU. The lowest z score is 2.71 for which α = .003, when SP is compared to DC. For SPU evaluated in Table 3, the equality of the distributions cannot be rejected only when it is compared to DC.

<u>Conclusion 2</u>. The inclusion of unanimity reduces the overall efficiency of the process.

<u>Support</u>. From Table 2 the addition of unanimity is associated with a fall in the overall provision level in both SP (provision goes from 13.7 to 10.6) and DC (provision goes from 4.7 to 1.2). These reductions are significant when comparing DC to DCU (z = 5.18) but the differences have very low significance (z = .80, α = .21) when comparing SP to SPU.

TABLE 2
AVERAGE PROVISION LEVELS AND EFFICIENCIES

	Smith Process			Direct Contribution		
	x	y	z	x	y	z
With Unanimity	10.6 (48.7)	12.3 (57)	9.4 (44)	1.2 (8.0)	1.1 (7.0)	1.2 (8.0)
Without Unanimity	13.7 (66.5)	17.3 (86)	11.4 (51)	4.7 (32.0)	8.0 (53)	3.3 (21)

x = mean level of provision for all periods.
y = mean level of provision for "early" periods 1 and 2.
z = mean level of provision for "later" periods 3 and greater.

The numbers in parentheses are the associated mean efficiency (%) levels.

TABLE 3

WILCOXON RANK SUM TEST OF PROVISION LEVELS OF ALL PERIODS*

	G		
F	SPU	DC	DCU
SP	$z = 0.80$ $\alpha = 0.21$	$z = 2.71$ $\alpha = 0.003$	$z = 4.06$ $\alpha \simeq 0.00$
SPU		$z = 0.07$ $\alpha = 0.47$	$z = 2.65$ $\alpha = 0.004$
DC			$z = 5.20$ $\alpha \simeq 0.00$

*Ranks do not change if efficiency levels are used instead of provision levels since efficiencies increase as provisions increase to x = 24 units and in the cases where x > 24 units, the efficiencies still dominate.

Conclusion 3. In terms of overall provision levels (efficiency) the mechanisms can be ranked as follows:

$$SP \geq SPU \geq DC > DCU \quad \text{and} \quad SP > DC.$$

Support. Combine the results of conclusions 1 and 2.

Conclusion 4. The overall provision level (efficiency) in SP and DC falls with replication of periods.

Support. Table 2 shows the pooled data from the early periods (1 and 2) with the later periods (3 and greater). The provision in the early periods of SP is 17.3 and it is 11.4 for the later periods. For DC the levels are 8.0 and 3.3 respectively. From Table 4 these z-scores are seen to be 1.29 (α = .10) and 3.61 (α = .00) respectively. However, the SP results are sensitive to the zero allocations.

Conclusion 5. The overall provision level (efficiency) of DCU increases with replication of periods, and it falls in SPU, but not significantly.

Support. Table 2 shows the pooled data from the early periods (1 and 2) with the later periods (3 and greater). The provision in the early periods of SPU is 12.3 and it is 9.4 for the later periods. For DCU the levels are 1.1 and 1.2 respectively. From Table 4 these z-scores are seen to be .51 (α = .30) and .34 (α = .37) respectively. However, the results are sensitive to the zero allocations in either case.

TABLE 4

WILCOXON RANK SUM TEST
OF EARLY VS. LATER PROVISION LEVELS*

SPU	$z = 0.51$ $\alpha = 0.30$
SP	$z = 1.29$ $\alpha = 0.10$
DCU	$z = 0.34$ $\alpha = 0.37$
DC	$z = 3.61$ $\alpha \simeq 0.00$

*The hypothesis to be considered here is that there is no repetition effect against the alternative that early provision levels dominate later provision levels.

Summarizing the results of this section, three major features of the data are apparent. First, the Smith process is more efficient than is direct contribution. Secondly, the addition of unanimity to a mechanism is not an overall help to the performance level as measured so far. Third, the operation of time and experience does not serve to improve matters. In some cases the problems get worse. The inclusion of unanimity, however, prevents a significant decay in performance that occurs in its absence across the mechanisms.

2. Models of Individual Behavior

The next two conclusions provide useful background for considering models of individual behavior. Both conclusions identify aggregate behavior that hopefully is explicable in terms of models based on an individual level of analysis. We will then proceed to explore the available models as well as an ad hoc model in hope of finding an adequate explanation of these phenomena.

Conclusion 6. The sum of bids increases during a period of SP and SPU and decreases in DCU during a period (in DC there are no trials).

Support. From Table 5 we find that the mean bid in on the last trial is 1302 in SPU and 1206 in SP with standard deviations of 89.6 and 129.8 respectively. While the overall mean of 1272 for SPU and 1115 for SP with standard deviations of 260.3 and 256.0 respectively. Using a sign test to test equal probability of movements we obtain a z-score of 4.93 for SPU and 5.41 for SP so that sum of bids is increasing. Furthermore, the z-score is -2.82 for DCU so that sum of bids is decreasing.

Conclusion 7. Aggregate proposed quantities are near the Lindahl optimum for SPU and SP.

Support. Table 5 shows that the mean project size for all trials is 22.1 in SPU and 19.8 for SP and that for the last trial mean project sizes are 21.1 and 22.0 respectively. The range of the project levels is 13.6 to 33 for SPU and 11.1 to 29.6 for SP.

Given the dynamic structure of the experiments (e.g., a series of trials leading to a possible agreement), a Nash reaction model may provide an explanation for individual decision-making. Each individual adjusts bids and quantities to maximize utility given that the other participants leave their bids and quantities unchanged from the previous trial. Conceivably, some sort of Nash reaction would induce a dynamic feature that keeps quantities and bids moving in the "right" direction. Since the Nash reaction is a point response which is not likely to be seen, two weaker models are developed. These two additional models ask only if the variables are moving in the "right" direction.

The structure of a Nash gradient reaction model will be developed for the Smith process as follows. The extension to the DC mechanism is trivial. Let $b^{i*}_{t+1} \equiv 130¢ - \sum_{j\neq i} b^{j}_{t}$ and x^{i*}_{t+1} denote Nash bid and project level reactions for individual i at time t. Since we truncated the message spaces in our experiment, i.e., $b^{i}_{t} \geq 0$ and $x^{i}_{t} \in [0,\hat{x}]$, where $\hat{x} = 40$ for the high value group and 34 for the low

TABLE 5

MEAN AND STANDARD DEVIATION OF
PERIOD-TRIAL BIDS AND PROJECT LEVELS*

	Sum of Bids		Project Level	
Process	Mean	Standard Deviation	Mean	Standard Deviation
SPU - All Trials	1272	260.3	22.1	3.98
Last Trial of Period	1302	89.6	21.1	2.37
Trials Period 3+	1245	261.5	22.5	4.21
SP - All Trials	1115	256.0	19.8	3.88
Last Trial of Period	1206	129.8	22.0	1.80
Trials Period 3+	1098	279.3	20.2	4.08
DCU - All Trials	--	--	7.6	6.48
End of Period	--	--	4.8	2.16
Trials Period 3+	--	6.7	3.17	
DC - All Periods	--	--	4.7	3.91
Period 3+	--	--	3.3	1.77

*Sign test for the equal probability of movement on the sum of bids yields

SPU	DCU	SP	DC
$z = 4.93$	$z = -2.820$	$z = 5.41$	$z = -2.830$
$\alpha \simeq 0.00$	$\alpha = 0.002$	$\alpha \simeq 0.00$	$\alpha = 0.002$

value group, we must have $b^{i*}_{t+1} \geq 0$ and $x^{i*}_{t+1} \varepsilon [0,\hat{x}]$; thus if $b^{i*}_{t+1} < 0$ we set $b^{i*}_{t+1} = 0$ and if $x^{i*}_{t+1} < 0$ we set $x^{i*}_{t+1} = 0$ and for $x^{i*}_{t+1} > \hat{x}$ we set $x^{i*}_{t+1} = \hat{x}$. Finally, we note that if profits are negative for any feasible x^{i}_{t+1}, given a price of $130¢ - \sum_{j\neq i} b^{j}_{t}$, then any reaction $x^{i*}_{t+1} \varepsilon [0,\hat{x}]$ and $0 \leq b^{i*}_{t+1} < 130¢ - \sum_{j\neq i} b^{j}_{t}$ would correspond to cost not being covered and thus zero profits. Hence, we will ignore the cases of negative profits for any $x^{i}_{t+1} \varepsilon [0,\hat{x}]$ with a price of $130¢ - \sum_{j\neq i} b^{j}_{t}$.

Now, let $\Delta^{i}_{x} = (x^{*i}_{t+1} - x^{i}_{t})(x^{i}_{t+1} - x^{i}_{t})$ if $x^{i*}_{t+1} \neq x^{i}_{t+1}$ and $\Delta^{i}_{x} = 1$ if $x^{i*}_{t+1} = x^{i}_{t+1}$; and $\Delta^{i}_{b} = (b^{i*}_{t+1} - b^{i}_{t})(b^{i}_{t+1} - b^{i}_{t})$ if $b^{i*}_{t+1} \neq b^{i}_{t+1}$ and $\Delta^{i}_{b} = 1$ if $b^{i*}_{t+1} = b^{i}_{t+1}$. We say that individual i exhibits <u>Nash gradient behavior</u> if $\Delta^{i}_{x} > 0$ and $\Delta^{i}_{b} > 0$ and i exhibits <u>weak Nash gradient behavior</u> if $\Delta^{i}_{x}, \Delta^{i}_{b} \geq 0$ but $\Delta^{i}_{x} \neq 0$ or $\Delta^{i}_{b} \neq 0$. Notice that the act of voting is considered as neither a strategic nor an informative variable in the behavioral model.

<u>Conclusion 8</u>. In both SPU and SP the overall response is consistent with weak Nash gradient reaction behavior.

<u>Support</u>. Table 6A presents the aggregate Δ_x or Δ_b counts for both SPU and SP. In every case, we can reject the hypothesis of equal probability of movement in project level and bids, in favor of movement in the Nash direction. We do note that there exists a substantial amount of cases of no changes in the bids and project level (see Table 6B).

<u>Conclusion 9</u>. In both DCU and DC the overall response is consistent with Nash gradient reaction behavior.

<u>Support</u>. Table 6C shows the number of responses in each of the possible directions of movement. The z-score on the equal probability of move implies rejection in favor of movement in the Nash direction for DCU and DC.

Turn now to a static model of individual behavior, namely the Lindahl equilibrium. The Smith experiments (1979b; 1980) suggest that one should check on the possibility of Lindahl behavior directly. Lindahl behavior might emerge even though an explanation in terms of strategic behavior is lacking. Of course in SP and SPU the Lindahl optimum is also a perfect Nash equilibrium. The following two conclusions demonstrate that the choices themselves are not Lindahl.

<u>Conclusion 10</u>. High/low payoff group bids (after rebate) approximate equality, i.e., groups tend toward equal contribution when agreement occurs.[5]

<u>Support</u>. Table 7 gives the mean bids and project levels for agreement periods by demand group, while Table 8 displays the test for equal (130¢) bids across groups. Testing the hypothesis that the bids from the high value and low value groups come from the same distribution upon agreement (nonzero provision successfully implemented) we obtain z-scores of z = 1.20 for SPU and z = 0.21 for SP via the Wilcoxon rank sum. Applying a parametric test of the equality of mean bids from

TABLE 6A

NASH GRADIENT REACTION[a]

Process	$\Delta \geq 0$[b]	$\Delta \geqq 0$[c]
SPU	(441/686) 64%	(512/757) 68%
	$z = 7.48$	$z = 9.70$
	$\alpha \simeq 0.00$	$\alpha \simeq 0.00$
SP	(233/361) 65%	(290/418) 59%
	$z = 5.53$	$z = 7.94$
	$\alpha \simeq 0.00$	$\alpha \simeq 0.00$

a. $\Delta \equiv (\Delta_x, \Delta_b)$ with the standard formulation that:

$\Delta > 0 \quad \Leftrightarrow \quad \Delta_x, \Delta_b > 0$

$\Delta \geqq 0 \quad \Leftrightarrow \quad \Delta_x, \Delta_b \geqq 0$

$\Delta \geq 0 \quad \Leftrightarrow \quad \Delta_x, \Delta_b \geqq 0$

but

$\Delta_x > 0$ or $\Delta_b > 0$

b. The z-score is based on the test of the null hypothesis that, given there was movement in at least one dimension, there is equal probability of positive-zero and negative (any direction) against the alternative of movement in positive-zero direction. If we consider $\Delta > 0$ as the only positive movement, we obtain (197/686) for SPU and (116/361) for SP.

c. The z-score is based on the null hypothesis of equal probability of non-negative and negative (any direction) movement against the alternative of non-negative movement.

TABLE 6B

NASH GRADIENT REACTION PER MESSAGE DIMENSION*

	$\Delta_x > 0$	$\Delta_x \geq 0$	$\Delta_x < 0$	$\Delta_b > 0$	$\Delta_b \geq 0$	$\Delta_b < 0$
SPU	261	595	162	328	645	112
	$z = 4.82$			$z = 17.16$		
	$\alpha \simeq 0.00$			$\alpha \simeq 0.00$		
SPU	155	321	97	215	314	104
	$z = 3.65$			$z = 6.22$		
	$\alpha \simeq 0.00$			$\alpha \simeq 0.00$		

* The z-scores are based on the test of null hypothesis that, given there was movement in the stated direction, there is an equal probability of positive negative movement against the alternative of movement in the Nash direction.

TABLE 6C
NASH GRADIENT REACTION*

Process	$\Delta_b > 0$	$\Delta_b \geq 0$	$\Delta_b < 0$
DCU	609	1127	283
	$z = 10.87$		
	$\alpha \simeq 0.00$		
DC	1.84	276	64
	$z = 7.62$		
	$\alpha \simeq 0.00$		

* The z-scores are based on the test of the null hypothesis that, given there was movement in bids, there is an equal probability of positive-negative movement against the alternative of movement in the Nash directions.

TABLE 7

BID AND PROJECT LEVEL RESPONSE
BY GROUP UPON "AGREEMENTS"

High Group	SPU	SP	DCU	DC
· Mean Bid[a]	139.3	132.1	1425	781
· Standard Deviation of Bid	66.3	89.1	830	1042
· Mean Project Level[b]	28.1	23.3	--	--
· Standard Deviation of Project Level	14.6	13.3	--	--
Low Group				
· Mean Bid	120.7	127.9	906	417
· Standard Deviation of Bid	72.6	110.5	1001	690
· Mean Project Level[c]	14.3	16.1	--	--
· Standard Deviation of Project Level	11.3	10.1	--	--

a. All bids are expressed in francs (1000 francs = 1 U.S. dollar) with rebate.

b. The optimal project size for high group with median bid of 139.3 is 27.4 and 132.1 is 28.0.

c. The optimal project size for low group with median bid 120.7 is 18.9 and 127.9 is 18.5.

TABLE 8

HIGH/LOW GROUP BIDS*

Mechanism	Rank Sum	t-test (equal means)
SPU	$z = 1.20$ $\alpha = 0.22$	$t = 0.95$ (df = 138) $\alpha = 0.32$
SP	$z = 0.21$ $\alpha = 0.42$	$t = 0.32$ (df = 208) $\alpha = 0.70$

* The 95% Confidence Intervals (francs) per payoff group and process are:

	SPU	SP
High	$(126.1 \leq b \leq 152.5)$	$(117.8 \leq b \leq 146.5)$
Low	$(106.0 \leq b \leq 135.4)$	$(111.1 \leq b \leq 144.7)$

each group we obtain $t = .95$ ($\alpha = .32$) for SPU and $t = .32$ ($\alpha = .70$) for SP.

The results reported in conclusion 10 together with other aspects of the data set the stage for investigating an ad hoc model of individual choice behavior. Conclusion 10 suggests that a bargaining process among agents who are uninformed of the payoff of others is leading to an equal split similar to those observed by Roth (1983). Ten people splitting the 130¢ unit cost of the project results in a per person bid of 13¢ which approximately fits the facts. From the payoff charts one can determine that the optimum quantity for the high demand group facing such a price is 28 units and for the low demand group is 18 units. Suppose the five high demanders submitted quantity bids $q_i = 28$ rather than the q_i that would influence $\bar{q}$ in an optimum manner. Suppose further, the low demanders followed a similar strategy and submitted $q_i = 18$. The Smith process would produce the "welfare maximizing" quantity of 23 units and thus operates at 100 percent efficiency given that costs were actually covered. Table 7 shows that, in SPU, the mean quantities are 28.1 and 14.3 units, giving a quantity of 21.2 units. The ad hoc model thus seeks to explain the high efficiency levels of the Smith process as resulting from (1) equality of bids, (2) truthful revelation of desired quantity given bids, and (3) parameter choices that lead (1) and (2) to generate optimal group choices of quantity.

The next result tests the ad hoc model against an appropriately modified Nash reaction model. The question posed is whether the choices of q_i, given the individual's bid, are closer to the optimal Nash reaction or to demand revelation.

Conclusion 11. The Nash reaction model is better (with marginal significance) in SPU than the *ad hoc* model but in SP the *ad hoc* model is better.

Support. For both models the distribution of errors was calculated. (error = quantity choice predicted by the model minus actual quantity chosen). The results are in Table 9. In SPU the average error (standard deviation) for the Nash reaction model and the *ad hoc* model were respectively 1.04 (17.6) and 1.78 (12.1). The difference is significant at the .05 level of confidence. The error of the Nash model is on average smaller but the large variances suggest that the models are behaving badly. In SP the numbers for Nash and *ad hoc* are respectively 8.2 (16.4) and 5.9 (11.5). In this case the errors of the *ad hoc* are on average smaller and the difference in averages is significant at .01 level of confidence. However, the variances are again very large, suggesting that additional theory is required.

3. Conjectured Performance Tradeoffs

Ex post data analysis suggests the existence of performance tradeoffs as one varies mechanisms. The first tradeoff is between the efficiency of the choice given the occurrence of a *success* (i.e., a nonzero provision level was successfully implemented) and the rate of success. The second is a tradeoff between the success rate and the occurrence of *bankruptcy* (i.e., a period in which an individual loses

TABLE 9

AVERAGE ERROR FROM PREDICTED MODEL
(Standard Deviation)

	SPU	SP
Nash Reaction Model	1.04 (17.6)	8.2 (16.4)
Ad Hoc Model	1.78 (12.1)	5.9 (11.5)

money). The following conclusions regarding the possible tradeoffs are tentative however; some of the observed differences in means are not significant.

The first tradeoff can be seen in Table 10. Provision levels given a success go up with unanimity, while the success rate goes down. The lower success rate more than offsets the increase in provision levels given success, as can be inferred from conclusion 2 above. A histogram is shown as Figure 7.

Conclusion 12. Unanimity decreases the success rate of the mechanism.

Support. From Table 10 we see that conditional on unanimity the success rate is lower; .50 SPU vs. .67 SP and .13 DCU vs. 1.00 DC. Testing the equality of the proportion of failure per mechanism we find in Table 11 that z = 1.56 (α = .06) for SPU and SP; z = 7.25 ($\alpha \simeq$ .00) for DCU and DC.

Conclusion 13. Unanimity increases the efficiency of the mechanisms given a success (nonzero provision) but not significantly.

Support. The mean values are in Table 10. Table 12 provides the rank sum test statistics for the nonzero provision periods. While the mean provision is higher for SPU (21.3) than SP (19.7) the z-score is 1.11 (α = .13) and t = 1.30 (α = .20) for equality. It is clear that the Smith process distribution dominates the direct contribution process when nonzero provisions are considered (lowest z = 2.53).

TABLE 10

TRADEOFF ANALYSIS

	Smith Process			Direct Contribution		
	x	y	z	x	y	z
With Unanimity	21.3 (97.3)	50	7	8.9 (57.5)	13	67
Without Unanimity	19.7 (95)	67	62	4.7 (32.0)	100	60

x = mean level (efficiency) for success periods.
y = percent of success periods.
z = percent of success periods with at least one bankruptcy.

The numbers in parentheses are the associated mean efficiency levels.

FIGURE 7 PROJECT LEVEL HISTOGRAM

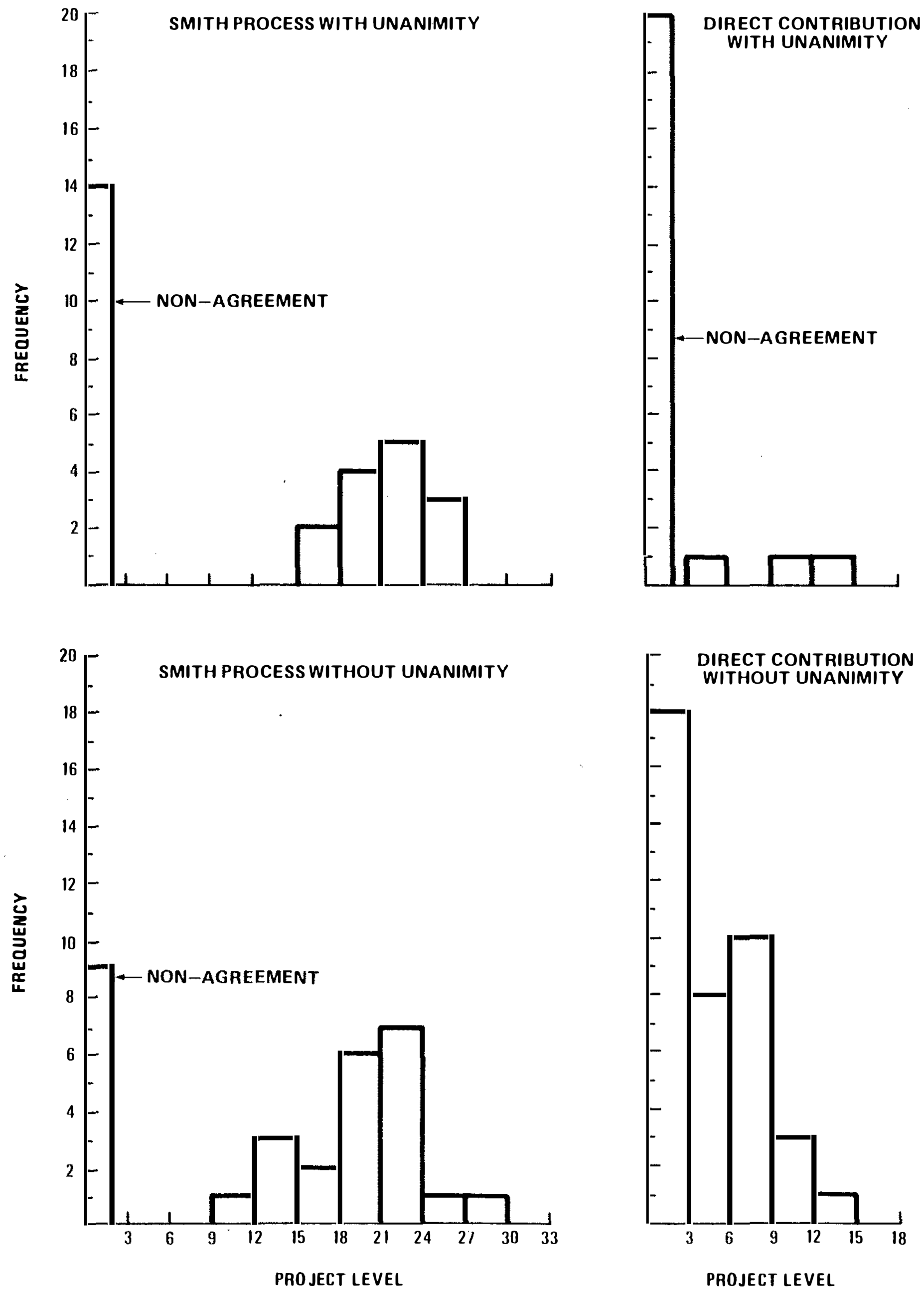


TABLE 11

TEST ON PROPORTION OF FAILURES BY PROCESS*

	p_2 [a]	
p_1	SP [b]	DC [c]
SPU	$z = 1.56$ $\alpha = 0.06$	$z = 5.00$ $\alpha \simeq 0.00$
DCU	$z = 4.13$ $\alpha \simeq 0.00$	$z = 7.25$ $\alpha \simeq 0.00$
SP		$z = 3.75$ $\alpha \simeq 0.00$

*The 95 percent confidence intervals for the proportion of failures (p) are:
SPU - $(.31 \lesssim p \lesssim .69)$ DCU - $(.68 \lesssim p \lesssim .96)$ SP - $(.16 \lesssim p \lesssim .48)$.

a. A normal approximation to the binomial is used to test $H_a : p_1 = p_2$.

b. Using a contingency table to test failure rate of SPU = failure rate SP, we obtain $\chi^2(1) = 1.81$.

c. Using a contingency table to test failure rate of DCU = failure rate DC, we obtain $\chi^2(1) = 47.61$.

TABLE 12

WILCOXON RANK TEST FOR NONZERO PROVISION*

	G		
F	SP	DC	DCU
SPU	$z = 1.11$ $\alpha = 0.13$	$z = 5.40$ $\alpha \simeq 0.00$	$z = 2.64$ (T = 6) $\alpha = 0.04$
SP		$z = 6.20$ $\alpha \simeq 0.00$	$z = 2.53$ (T = 8) $\alpha = 0.006$
DC			$z = 1.69$ (T = 3) $\alpha = 0.65$

*Confidence Intervals for Smith Process are

$$SPU = (19.3 \lesssim \mu \lesssim 23.4)$$

$$SP = (17.2 \lesssim \mu < 22.2)$$

t-test for equal means SPU, SP yields t = 1.2. However F-test for equal variances yields F = 3.46. The modified t = 1.30.

Conclusion 14. Unanimity reduces the effect of bankruptcies.

Support. In Table 13 we find that the loss per period in SP (165¢) is greater than in SPU (25¢). Similarly, for DC, the loss per period (68¢) is greater than in DCU (11¢). If average loss per bankruptcy is weighted by the proportion of bankruptcy periods, i.e.,

$$\left[\frac{\sum_{i=1}^{\ell} \text{loss}_i}{\ell}\right]\left[\frac{\text{number of bankruptcy periods}}{\text{number of periods}}\right],$$

where i indexes losses, then we find the same ranking being maintained: SP = 118¢, SPU = 25¢, DC = 57¢, DCU = 6¢.

The role of time and replication proved to be important in the overall performance of the mechanism. Hence it is natural to check for any effects on the success periods. As above our comparisons involve the first two periods (early periods) vs. periods three and greater (late periods).

The following conclusion suggests that a tradeoff between the efficiency given success and the rate of success may exist over time as well as across mechanisms.

Conclusion 15.

(i) Considering only successful periods of SP and SPU the levels are lower during the first two periods than in later periods. The differences are not significant.

(ii) The success rate goes down (up) with replications in SPU (DCU)

TABLE 13

MEASURES OF BANKRUPTCY BY PROCESS*

	Magnitudes of Bankruptcy		
Process	(a) Loss per Period ($)	(b) Average Number of Participants Suffering Loss in Loss Period	(c) = (a)/(b) Weighted Loss per Occurrence of Loss ($)
SPU	0.25	1.0	0.25
SP	1.65	1.4	1.18
DCU	0.11	2.0	0.06
DC	0.68	1.2	0.57

but not significantly.

(iii) The success rate goes down in SP with replication.

Support.

(i) Table 14 shows that mean difference of provision levels from later vs. early periods is .30 for SPU and 1.60 for SP. The z-scores (Table 15), however, are $z = .25$ ($\alpha = .49$) for SPU and $z = .66$ ($\alpha = .25$) for SP. In Table 14 the sign test yields $z = .71$ ($\alpha = .24$) for SPU and $z = 1.60$ ($\alpha = .055$) for SP.

(ii)-(iii) The mean difference of the failure rates from later vs. early periods is .14 for SPU and .36 for SP. Table 15 provides the test of equal proportion of failures in periods one and two and periods three on, the $z = .74$ ($\alpha = .23$) for SPU, $z = 2.11$ ($\alpha = .017$) for SP, and $z = -.70$ ($\alpha = .24$) for DCU.

4. Strategic Use of Unanimity

Unanimity changes the set of Nash equilibria in the game representations of the mechanisms so reasons exist to suspect that it will influence the strategies used by participants. The next two results identify some of the effects of unanimity on individual behavior. The first result suggests that unanimity encourages higher bidding by removing any risk of loss associated with higher bids. The higher bidding activity increases the likelihood that costs will be covered in the Smith process and increases the efficiency level of success periods in the direct contribution mechanism. The second result indicates that unanimity can be used as a bargaining tool in

TABLE 14

THE EFFECT OF REPETITION ON THE PROCESS*

	Mean Provision $x > 0$		Failure Rate	
Process	Periods 1 and 2	Periods 3+	Periods 1 and 2	Periods 3+
SPU	21.1	21.4	.42	.56
SP	18.9	20.5	.08	.44
DCU	13.7	6.6	.92	.82
DC	8.0	3.3	0	0

*Sign Test (Equal Probability of Movement for Provision Levels) Yields:

SPU	DCU	SP	DC
$z = 0.77$ ($x \geq 0$)	$z = 1.09$ ($x \geq 0$)	$z = -2.82$ (trials)	$z = -2.83$
$z = 0.71$ ($x > 0$)	$z = 1.60$ ($x > 0$)	$z = -1.21$ (e.o.p.)	
$z = 0.23$ (e.o.p.)	$z = 1.63$ (e.o.p.)		

e.o.p. = end of period project levels
$x > 0$ = success periods allocations
$x \geq 0$ = all periods allocations

TABLE 15

TEST OF REPETITION EFFECT
Period 1 and 2 vs. Periods 3+

	Successful Provision Levels[a]	Failure[b] Rate
SPU	$z = 0.25$ $\alpha = 0.49$	$z = 0.74$[c] $\alpha = 0.23$
SP	$z = 0.66$ $\alpha = 0.25$	$z = 2.11$[d] $\alpha = 0.017$
DCU	$z = 2.40$ $\alpha \simeq 0.008$	$z = -.70$[e] $\alpha = 0.24$

a. Test based on Wilcoxon Rank Sum where the null hypothesis is that repetition does not matter, and the alternative is that Periods 1 and 2 dominate Periods 3+.

b. Test based on normal approximation to binomial to test difference in failure rate with the alternative hypothesis being that the failure rate grows with repetition. The sample sizes are small so that the normal approximation may not hold.

c. Using a contingency table to test failure rate periods 1 and 2 = failure rate periods 3+ yields $\chi^2(1) = .14$.

d. $\chi^2(1) = 1.39$ from contingency table.

e. $\chi^2(1) = 1.20$ from contingency table.

which participants attempt to benefit themselves at the possible expense of others.

Conclusion 16. The sum of bids in both mechanisms tends to be larger with unanimity than without.

Support. Testing whether the sum of bids come from the same distribution with or without unanimity we obtain $z = 6.03$ ($\alpha \simeq .00$) for SPU vs. SP and $z = 2.95$ ($\alpha = .002$) for DCU vs. DC from Table 16. Applying a parametric test for the equality of means of sum of bids we find $t = 4.88$ ($\alpha \simeq .00$) for SPU vs. SP and $t = 2.58$ ($\alpha = .01$) for DCU vs. DC.

Conclusion 17. The following strategic uses of unanimity are evident.

(i) voting no with positive profits occurs on nonfinal trials but never on last trials for SPU;

(ii) no votes with positive profits are followed by lower bids;

(iii) the addition of unanimity in the Smith process pushes the process to the final trials.

Support.

Table 17 shows that 46 (67) percent of the no votes in SPU (DCU) were registered by participants making positive profits. Furthermore,

(i) 35 (70) percent of the participants in SPU (DCU) voted no with positive profits at least once. However, participants never

TABLE 16

TEST ON SUM OF BIDS

	SP		DC	
SPU	z = 6.03	α ≃ 0.0		
	t = 4.88	α ≃ 0.0		
DCU			z = 2.95	α = .002
			t = 2.587	α = .01

TABLE 17

STRATEGIC USE OF UNANIMITY RULE BY INDIVIDUALS

	SPU	DCU
Percent of individuals voting no with positive profits	(21/60) - 35	(42/60) - 70
No votes with positive profits as a percent of total no votes	(35/76) - 46	(269/401) - 67
Number of no votes on last trial of period with positive profits	0	19*
Percent of individuals who never vote no with positive profits if previously such a strategy resulted in lower profits	(11/14) - 79	(15/42) - 36

*Eleven out of twenty-two last trials had at least one no vote from an individual making positive profits.

vote no with positive profits on the last trial of a period in SPU (19 no votes were registered on the last trial of a period in DCU by individuals making positive profits).

(ii) Table 18 shows that 71 percent of those individuals voting no with positive profit <u>reduce</u> their bids for the next trial.

(iii) From Table 19 we notice that SPU uses all the possible trials in 82 percent of periods while SP has only 47 percent of the periods using all the trials.

VI. CONCLUDING REMARKS

From a practical point of view the experiments were successful in a negative sort of way. The Smith process does not reliably deliver public goods decisions at near 100 percent levels of efficiency. In efficiency terms the performance of the process will be sensitive to the parametric environment. In particular the performance of the mechanism decreases with repeated use rather than increases as one might have hoped. This fact bears importantly on the space station research project. A more reliable process must be found before we proceed with an application at the practical/political level of analysis.

On a more positive note the Smith process performs much better than a direct contribution process. Both the performance over all periods is better and the performance over time is better. These experiments leave no doubt that the quality of public goods decisions can be substantially affected by the choice of mechanism. Surprisingly, unanimity decreased the efficiency with which either

TABLE 18

CHANGE IN BIDS AFTER AGREEMENT OR FAILURE

	SP	SPU
Percent of bids that do not increase if there is a no vote	--	74
Percent of bids that decrease if there is a no vote	--	43
Percent of bids that do not increase if there is a no vote or end of period (e.o.p.)	83	82
Percent of bids that decrease if there is a no vote or e.o.p.	62	51
Percent of bids that decrease if individual voted no with loss	--	93
Percent of bids that decrease if individual voted no with positive profit	--	71
Percent of bids that do not increase if cost not covered at e.o.p.	82	50

TABLE 19

PROPORTION OF TRIALS USED BY PROCESSES

	All Trials Used	Agreement on Last Trial
SPU	(23/28) - 82%	(9/23) - 39%
SP	(14/30) - 47%	(5/14) - 36%
DCU	(22/23) - 96%	(2/22) - 9%

mechanism functioned. This result is directly counter to expectations formed from data and conjectures found in the literature.

A puzzle remains about the reason for the relatively good performance of the Smith process. Individuals do not seem to be revealing Lindahl prices as one might expect from studying previous work. Some support exists for a Nash gradient response model. Analysis of the data also yields support for an _ad hoc_ model of individual decisions. This lack of resolve and the high variances in errors suggest that more research is necessary on this issue.

A tradeoff in performance qualities can be detected. Much of the low levels of efficiencies in the Smith process can be attributed to a low success rate. When groups do not cover cost and attain an agreement within a prespecified number of trials, the chosen level of the public good is zero by default. Unanimity has the property of _decreasing_ the success rate and increasing the efficiency given that a success occurs. This latter tendency, however, is not statistically significant. Part of the failures when unanimity is added can be understood in terms of bankruptcy avoidance and therefore perhaps the failures are not a dead weight loss due to unanimity. Unanimity does remove a bankruptcy problem. However, unanimity does more than eliminate bankruptcies because it is a tool that can be used strategically. Several of the conclusions of the paper are devoted to an attempt to detect such strategic behavior.

APPENDIX A

SPU
INSTRUCTIONS

You are about to participate in a decision process in which one of numerous competing alternatives will be chosen. This is part of a study intended to provide insight into certain features of decision processes. If you follow the instructions carefully and make good decisions, you might earn a considerable amount of money. You will be paid in cash.

This decision process will proceed as a series of periods or days during which a project level will be determined and financed. The "level" can be at zero "units" or more, the exact level of which must be determined. Attached to the instructions you will find a sheet, which describes the value to you of decisions made during the process, called the Redemption Value Sheet. You are not to reveal this information to anyone. It is your own private information.

During each period a level of the project will be determined. For the first unit provided during a period you will receive the amount listed in row 1 of the Redemption Value Sheet. If a second unit is also provided during the period, you will receive the additional amount listed in row 2 of the Redemption Value Sheet. If a third unit is provided, you will receive, in addition to the two previous amounts, the amount listed in row 3, etc. As you can see, your individual total payment is computed as a sum of the redemption values of specific units. (These totals of redemption values are tabulated for your convenience on the right-hand side of the page.)

The earnings each period, which are yours to keep, are the differences between the total of redemption values of units of the project provided and your individual expenditures on the project. All values are stated in francs and can be converted into cash at a rate of _____ francs per dollar at the end of the experiment. Suppose, for example, your Redemption Value Sheet was as below and two units were provided.

REDEMPTION VALUE SHEET

Project Level (Units)	Redemption Value of Specific Units (Francs)	Total Redemption Value of All Units (Francs)
1	2500	2500
2	1500	4000
3	1000	5000

Your redemption value for the two units would be 4000 and your earnings would be computed by subtracting your individual expenditures from this amount. If 2.5 units were provided, the redemption value would be determined by the redemption values of the first and second unit plus one half of the third unit, that is,

$$2500 + 1500 + (.5)1000 = 4500.$$

Each unit of the project costs _____ francs. Hence, total cost for a project is _____ times the project size. Your portion of total project cost for a period is determined from the decisions that result from a series of trial bids using the following process (refer to the period Record Sheet in your folder for recording the results of each trial).

At the beginning of a trial in a period you will select a bid expressed in francs and a project level expressed in whole numbers. During the trial you will enter your bid choice in the second row of the Record Sheet, your proposed project level in the third row of the Record Sheet, and both of these numbers on the appropriate choice card contained in your folder. After the choice cards are collected, the sum of all the bids and the average proposed project level will be displayed on the blackboard. Record the sum of the bids in row 1 and the average proposed project level in row 7 of your Record Sheet.

Your potential price per unit of the project is the difference between the unit cost of the project and the sum of all others' bids. Thus, to obtain your potential price per unit of the project subtract row 1 from your bid in row 2 of the Record Sheet. Suppose, for example, you were to bid 200 francs and the sum of all bids is 1000, your potential price would then be 1300 - (1000 - 200) = 500 francs. Your potential payment is your potential price times the average proposed project level. This number should be entered in row 9 of the Record Sheet. Hence, if the average proposed project level were 8 units then your potential cost for 8 units from the above example would be 8 x 500 = 4000 francs.

The potential value to you of the trial decision is obtained from your Redemption Value Sheet by finding the row for the proposed average project level and then placing the number found in the Total Redemption Value column in row 8 of the Record Sheet. Your possible earnings of the trial decision is the difference between your Total Redemption Value and your cost of the average proposed project level. This number should be placed in row 10 of the Record Sheet. Thus, if your Total Redemption Value for 8 units were 6500 francs, your potential earnings from the above example would be 6500 - 4000 = 2500 francs.

In order for your potential earnings on a given trial to be awarded for the period, TWO events must occur.

1. Each participant's bid must equal his/her potential price. If the sum of all bids exceeds the unit cost _____ of the project, all participants get a rebate in proportion to their bid such that the new bid of each is equal to his/her potential price.

2. All participants vote "yes" on their voting pad. If any participant votes "no," then the decision will not be finalized and the group will go to the next trial.

A maximum of _____ trials for period 1 and _____ trials for all subsequent periods will be permitted. If the process stops by these rules the earnings in your agreement trial for the period will be yours to keep. If no agreement is reached for the period as defined above you will obtain no earnings for the period.

The Redemption Value Sheet is not the same for all participants. Feel free to earn as much as you can. Are there any questions?

Review Questions

1. The additional redemption value for the ninth unit is _____. Your total redemption value for a project of size 3 units is _____; for a project of size 17.5 units is _____; for a project of size 30.1 units is _____.

2. Suppose there were three individuals in the experiment and the following bids and project levels were tendered.

1	2	3
Bid = 100	Bid = 50	Bid = 150
Project Level = 20	Project Level = 10	Project Level = 6

Then the sum of bids is _____ and the average proposed project level is _____.

3. Suppose the total of <u>others'</u> bids (<u>not</u> including yours) is 1200 francs and the average proposed project level (including your proposal) is 15.

   (i) Your total redemption value for the average project level is _____.

   (ii) If you were to have bid 100 francs would the group proceed to vote? _____. Your potential price would be _____ and potential payment _____ in this example.

   (iii) If you were to have bid 200 francs would the group proceed to vote? _____. Since costs are more than covered your rebate factor would be .93. The total sum of revised bids would be 1300 francs, your revised bid would be _____, and your potential payment _____ in this example.

   (iv) If you were to have bid 50 francs would the group proceed to vote? _____. Your potential price would be _____ and your potential payment _____ in this example.

SP
INSTRUCTIONS

You are about to participate in a decision process in which one of numerous competing alternatives will be chosen. This is part of a study intended to provide insight into certain features of decision processes. If you follow the instructions carefully and make good decisions, you might earn a considerable amount of money. You will be paid in cash.

This decision process will proceed as a series of periods or days during which a project level will be determined and financed. The "level" can be at zero "units" or more, the exact level of which must be determined. Attached to the instructions you will find a sheet, which describes the value to you of decisions made during the process, called the Redemption Value Sheet. <u>You are not to reveal this information to anyone</u>. It is your own private information.

During each period a level of the project will be determined. For the first unit provided during a period you will receive the amount listed in row 1 of the Redemption Value Sheet. If a second unit is also provided during the period, you will receive the additional amount listed in row 2 of the Redemption Value Sheet. If a third unit is provided, you will receive, in addition to the two previous amounts, the amount listed in row 3, etc. As you can see, your individual total payment is computed as a sum of the redemption values of specific units. (These totals of redemption values are tabulated for your convenience on the right-hand side of the page.)

The earnings each period, which are yours to keep, are the differences between the total of redemption values of units of the project provided and your individual expenditures on the project. All values are stated in francs and can be converted into cash at a rate of _____ francs per dollar at the end of the experiment. Suppose, for example, your Redemption Value Sheet was as below and two units were provided.

REDEMPTION VALUE SHEET

Project Level (Units)	Redemption Value of Specific Units (Francs)	Total Redemption Value of All Units (Francs)
1	2500	2500
2	1500	4000
3	1000	5000

Your redemption value for the two units would be 4000 and your earnings would be computed by subtracting your individual expenditures from this amount. If 2.5 units were provided, the redemption value would be determined by the redemption values of the first and second unit plus one half of the third unit, that is,

$$2500 + 1500 + (.5)1000 = 4500.$$

Each unit of the project cost ____ francs. Hence, total cost for a project is ____ times the project size. Your portion of total project cost for a period is determined from the decisions that result from a series of trial bids using the following process (refer to the period Record Sheet in your folder for recording the results of each trial).

At the beginning of a trial in a period you will select a bid expressed in francs and a project level expressed in whole numbers. During the trial you will enter your bid choice in the second row of the Record Sheet, your proposed project level in the third row of the Record Sheet, and both of these numbers on the appropriate choice card contained in your folder. After the choice cards are collected, the sum of all the bids and the average proposed project level will be displayed on the blackboard. Record the sum of the bids in row 1 and the average proposed project level in row 7 of your Record Sheet.

Your potential price per unit of the project is the difference between the unit cost of the project and the sum of all others' bids. Thus, to obtain your potential price per unit of the project subtract row 1 from your bid in row 2 of the Record Sheet. Suppose, for example, you were to bid 200 francs and the sum of all bids is 1000, your potential price would then be 1300 - (1000 - 200) = 500 francs. Your potential payment is your potential price times the average proposed project level. This number should be entered in row 9 of the Record Sheet. Hence, if the average proposed project level were 8 units then your potential cost for 8 units from the above example would be 8 x 500 = 4000 francs.

The potential value to you of the trial decision is obtained from your Redemption Value Sheet by finding the row for the proposed average project level and then placing the number found in the Total Redemption Value column in row 8 of the Record Sheet. Your possible earnings of the trial decision is the difference between your Total Redemption Value and your cost of the average proposed project level. This number should be placed in row 10 of the Record Sheet. Thus, if your Total Redemption Value for 8 units were 6500 francs, your potential earnings from the above example would be 6500 - 4000 = 2500 francs.

In order for your potential earnings on a given trial to be awarded for the period, the cost must be covered; that is, the sum of the bids must be greater than or equal to ____ francs. If the sum of the bids exceeds the unit cost ____ francs of the project, all participants get a rebate in proportion to their bid such that the sum of the new bids is equal to ____ francs.

A maximum of ____ trials for period 1 and ____ trials for all subsequent periods will be permitted. If the process stops by these rules the earnings in our agreement trial for the period will be yours to keep. If no agreement is reached for the period as defined above you will obtain no earnings for the period. Each participant

will be given some initial working capital ____ francs which will be paid in addition to any period earnings at the end of the experiment.

The Redemption Value Sheet is not the same for all participants. Feel free to earn as much as you can. Are there any questions?

Review Questions

1. The additional redemption value for the ninth unit is _____. Your total redemption values for all units of a project of size 3 units is _____; for a project of size 17.5 units is _____; for a project of size 30.1 units is _____.

2. Suppose there were three individuals in the experiment and the following bids and project levels were tendered.

1	2	3
Bid = 100	Bid = 50	Bid = 150
Project Level = 20	Project Level = 10	Project Level = 6

   Then the sum of bids is _____ and the average proposed project level is _____.

3. Suppose the total of <u>others'</u> bids (<u>not</u> including yours) is 1200 francs and the average proposed project level (including your proposal) is 15.

   (i) Your total redemption value for the average project level is _____.

   (ii) If you were to have bid 100 francs would the process stop? _____. Your potential price would be _____ and potential payment _____ in this example.

   (iii) If you were to have bid 200 francs would the process stop? _____. Since costs are more than covered your rebate factor would be .93. The total sum of revised bids would be 1300 francs, your revised bid would be _____, your potential price _____, and your potential payment _____ in this example.

   (iv) If you were to have bid 50 francs would the process stop? _____. Your potential price would be _____ and potential payment _____ in this example.

DCU
INSTRUCTIONS

You are about to participate in a decision process in which one of numerous competing alternatives will be chosen. This is part of a study intended to provide insight into certain features of decision processes. If you follow the instructions carefully and make good decisions, you might earn a considerable amount of money. You will be paid in cash.

This decision process will proceed as a series of periods or days during which a project level will be determined and financed. The "level" can be at zero "units" or more, the exact level of which must be determined. Attached to the instructions you will find a sheet, which describes the value to you of decisions made during the process, called the Redemption Value Sheet. <u>You are not to reveal this information to anyone</u>. It is your own private information.

During each period a level of the project will be determined. For the first unit provided during a period you will receive the amount listed in row 1 of the Redemption Value Sheet. If a second unit is also provided during the period, you will receive the additional amount listed in row 2 of the Redemption Value Sheet. If a third unit is provided, you will receive, in addition to the two previous amounts, the amount listed in row 3, etc. As you can see, your individual total payment is computed as a sum of the redemption values of specific units. (These totals of redemption values are tabulated for your convenience on the right-hand side of the page.)

The earnings each period, which are yours to keep, are the differences between the total of redemption values of units of the project provided and your individual expenditures on the project. All values are stated in cents. Suppose, for example, your Redemption Value Sheet was as below and two units were provided.

REDEMPTION VALUE SHEET

Project Level (Units)	Redemption Value of Specific Units	Total Redemption Value of All Units
1	600	600
2	500	1100
3	400	1500

Your redemption value for the two units would be 1100 and your earnings would be computed by subtracting your individual expenditures from this amount. If 2.5 units were provided, the redemption value would be determined by the redemption values of the first and second units plus one half of the third unit, that is,

$$600 + 500 + (.5)400 = 1300.$$

Each unit of the project cost _____. Hence, total cost for a project is _____ times the project size. Your portion of total project cost for a period is determined from the decisions that result from a series of trial bids using the following process (refer to the period Record Sheet in your folder for recording the results of each trial).

At the beginning of a trial in a period you will select a bid expressed in cents and place that number on your bid card and row 3 of your period Record Sheet. After the bid cards are collected they will be summed up and divided by _____ to obtain a proposed project level, which will be displayed on the board. Record the proposed project level in row 1 of your period Record Sheet.

Your potential earnings from the proposed project is the difference between your total redemption value from the proposed project and your bid. The potential value to you of the trial decision is obtained from your Redemption Value Sheet by finding the row for the proposed project level and then placing the number found in the Total Redemption Value column in row 2 of the Record Sheet. Thus, your possible earnings of the trial decision is the difference between your Total Redemption Value (row 2) and your bid (row 3). This number should be placed in row 4 of the Record Sheet.

In order for your potential earnings on a given trial to be awarded for the period, all participants would have to vote "yes" on their voting pad. If any participant votes "no," then the decision will not be finalized and the group will go to the next trial.

A maximum of _____ trials for period 1 and _____ trials for all subsequent periods will be permitted. If the process stops by these rules the earnings in your agreement trial for the period will be yours to keep. If no agreement is reached for the period as defined above you will obtain no earnings for the period.

The Redemption Value Sheet is not the same for all participants. Feel free to earn as much as you can. Are there any questions?

Review Questions

1. True or false. My earnings per period are the difference between the total of redemption values for the units of the project determined less the project cost per unit: _____.

2. For the ninth unit of the project, the additional redemption value for that specific unit is _____.

My total of redemption values for all units for a project of size 3 units is _____; for a project of size 17.5 units is _____; for a project of size 30.1 units is _____.

APPENDIX B

DATA FILE STRUCTURE*

Data Type	Field Location by Mechanism SPU	SP	DCU	DC
Period	1	1	1	2
Trial	2	2	2	-
Subject i:				
Bid Response	3i	2i+1	2i+1	i+2
Project Level	3i+1	2i+2	-	-
Vote	3i+2	-	2i+2	-
Sum of Bids	33	23	-	-
Proposed Project Level	34	24	23	13
Overall No Votes Per Trial	35	-	24	-

*Subjects 1-5 are the high payoff participants and subjects 6-10 are the low payoff participants. For SPU and SP bids are stated in francs (1000 francs = $1.00) while bids in DC and DCU are in cents.

Note: The sum of bids, proposed project level, and overall vote data presented are the actual numbers placed on the board as public information. Discrepancies due to incorrect calculation are denoted with footnotes indicating the correct calculation.

SPU

Experiment 1

1 1	100	20 0 100	20 0 400	20 0 420	4 0 300	14 0 200	7 0 50	28 1 140	17 0 500	10 1 130	5 0 2340	14.5 2
1 2	100	20 0 100	30 0 210	21 0 0	40 0 100	30 0 100	15 0 5	33 0 76	25 0 200	8 0 140	6 0 1031	22.8 0
1 3	100	20 0 100	30 0 190	23 0 100	30 0 150	26 0 50	10 0 13	34 0 100	22 0 50	20 0 130	5 0 983	22.0 0
1 4	200	20 0 110	35 0 200	15 0 200	30 0 150	26 0 100	4 0 50	15 0 132	18 0 80	20 0 140	5 0 1362	18.8 0
2 1	20	35 0 70	40 0 190	27 0 150	40 0 130	28 0 10	10 0 25	31 0 116	20 0 100	10 0 130	5 0 941	24.6 0
2 2	50	35 0 80	40 0 200	25 0 150	40 0 150	26 0 0	25 0 25	31 0 116	20 0 70	10 0 140	6 0 981	25.8 0
2 3	50	35 0 80	40 0 230	8 0 150	40 0 160	25 0 0	25 0 25	31 0 116	20 0 300	3 0 150	6 0 1261	23.3 0
2 4	40	35 0 80	40 0 235	0 0 140	40 0 150	26 0 0	27 0 40	31 0 126	20 0 550	10 0 150	6 0 1511	23.5 0
3 1	0	30 0 100	40 0 210	0 0 140	60 0 130	28 0 0	20 0 15	30 0 116	20 0 200	10 0 140	6 0 1061[a]	24.4 0
3 2	0	35 0 110	40 0 210	0 0 140	140 0 130	28 0 0	30 0 10	33 0 116	20 0 300	30 0 150	6 0 1166	32.6[b] 0
3 3	0	38 0 50	40 0 210	0 1 140	40 0 140	27 0 0	34 0 5	33 0 116	20 0 700	32 1 150	7 0 1511	27.1 2
3 4	0	35 0 100	30 0 165	0 0 130	60 0 140	27 0 0	34 0 0	34 0 116	20 0 150	32 0 150	5 0 941[c]	27.7 0
3 5	70	25 0 100	30 0 150	0 0 150	40 0 150	26 0 0	34 0 0	34 0 132	18 0 300	32 0 160	4 0 1212	24.3 0
4 1	0	25 0 100	30 0 150	0 0 140	60 0 130	28 0 0	30 0 0	34 0 116	20 0 200	32 0 140	4 0 976	26.3 0
4 2	0	25 0 150	0 0 170	0 0 140	80 0 150	26 0 0	25 0 0	34 0 117	19 0 400	32 0 160	3 0 1287	24.4 0
4 3	15	22 0 150	0 0 175	0 0 140	100 0 150	26 0 0	34 0 0	34 0 117	19 0 500	5 1 160	3 0 1407	24.3 1
4 4	20	20 0 200	0 0 176	0 0 140	200 0 150	26 0 0	25 0 0	34 0 116	19 0 100	5 0 160	1 0 1062	33.0 0
4 5	100	15 0 150	0 0 175	0 0 200	30 0 180	23 0 0	34 0 0	34 0 132	17 0 200	5 0 160	1 0 1297	15.9 0

a. 1051
b. 36.2
c. 951

SPU

Experiment 2

1 1	80	20 0 200	21 0 0	40 0 130	20 0 260	20 1 150	15 0 100	20 0 130	10 0 200	4 1 100	30 0 1350	20 2
1 2	80	40 0 200	21 0 50	40 0 140	25 0 200	30 0 100	20 0 100	25 0 100	5 0 250	5 0 50	22 0 1270	23.3 0
1 3	80	40 0 200	21 0 10	40 0 140	25 0 250	30 0 110	20 0 100	25 0 100	1 0 100	20 0 20	30 0 1110	25.2 0
1 4	90	40 0 200	21 0 25	40 0 140	30 0 250	30 0 100	18 0 110	25 0 100	0 0 135	20 0 50	22 0 1200	24.6 0
1 5	90	40 0 200	21 0 100	40 0 145	30 0 375	5 1 120	20 0 125	25 0 100	0 0 135	20 0 100	30 0 1490	23.1 1
1 6	90	40 0 200	21 0 0	40 0 145	30 0 200	40 0 115	20 0 125	20 0 90	0 0 125	20 0 75	30 0 1165	24.8[a] 0
1 7	100	40 0 200	21 0 20	40 0 145	30 0 170	40 0 125	30 0 150	15 0 100	0 0 135	20 0 100	1 0 1245	23.7 0
1 8	150	40 0 225	20 0 20	40 0 150	30 0 180	40 0 130	25 0 150	15 0 100	0 0 150	21 0 150	17 0 1305[b]	24.8 0
2 1	90	40 0 250	25 0 10	40 0 150	30 0 175	40 0 140	18 0 125	18 0 50	0 0 125	23 0 5	30 0 1120	26.4 0
2 2	90	40 0 250	25 0 20	40 0 150	30 0 175	40 0 150	20 0 125	18 0 80	0 0 135	20 0 30	30 0 1205	26.3 0
2 3	90	40 0 250	25 0 25	40 0 150	30 0 170	40 0 150	20 0 125	15 0 90	0 0 125	20 0 50	34 0 1225	26.4 0
2 4	95	40 0 250	25 0 40	40 0 160	30 0 160	40 0 150	30 0 150	15 0 90	0 0 125	20 0 5	34 0 1225	27.4 0
2 5	100	40 0 250	25 0 30	40 0 160	30 0 170	40 0 160	20 0 170	5 0 110	0 0 135	20 0 50	34 0 1335	25.4 0
3 1	80	40 0 250	30 0 0	40 0 160	30 0 160	40 0 140	20 0 130	10 0 100	0 0 125	21 0 5	34 0 1150	26.5 0
3 2	85	40 0 250	20 0 25	40 0 160	30 0 150	40 0 130	32 0 150	1 0 100	0 0 135	30 0 30	34 0 1215	26.7 0
3 3	80	40 0 250	40 0 35	40 0 160	30 0 145	40 0 135	25 0 150	1 0 100	0 0 125	5 0 25	34 0 1205	25.5 0
3 4	90	40 0 250	40 0 40	40 0 160	30 0 150	1 0 155	40 1 140	15 0 135	0 0 135	1 0 50	34 0 1305	24.1 1
3 5	95	40 0 250	40 0 50	40 0 160	30 0 160	30 0 135	25 0 150	1 0 135	0 0 125	19 0 60	34 0 1320	25.9 0
4 1	80	40 0 250	19 0 10	40 0 190	35 0 140	40 0 140	20 0 140	1 0 100	0 0 50	25 0 30	34 0 1130	25.4 0
4 2	80	40 0 250	15 0 150	40 1 190	35 0 140	40 0 145	25 1 150	1 0 105	0 0 135	5 0 20	34 0 1365	23.5 2
4 3	80	40 0 250	5 0 40	40 0 190	35 0 133	40 0 133	40 0 140	1 0 150	0 0 100	5 0 20	34 0 1236	24 0
4 4	85	40 0 250	1 0 50	40 0 190	35 0 130	40 0 145	26 0 150	1 0 100	5 0 135	5 0 25	34 0 1260	22.7 0
4 5	90	40 0 250	1 0 50	40 0 195	35 0 130	40 0 145	25 0 150	1 0 100	0 0 125	5 0 40	34 0 1275	22.1 0
5 1	80	40 0 250	1 0 0	40 0 200	35 0 120	40 0 140	28 0 150	1 0 0	34 0 10	15 0 20	34 0 970	26.8 0
5 2	90	40 0 250	1 0 60	40 0 200	35 0 200	15 0 160	15 1 150	1 0 50	34 0 135	25 0 50	34 0 1345	24 1
5 3	90	40 0 250	1 0 55	40 0 195	35 0 200	15 0 130	25 0 150	1 0 50	34 0 135	1 0 40	34 0 1295	22.6 0
5 4	90	40 0 250	1 0 50	40 0 195	35 0 180	20 0 130	25 0 150	1 0 50	0 0 135	1 0 20	34 0 1250	19.7 0
5 5	95	40 0 250	1 0 60	40 0 200	35 0 160	40 0 145	25 0 150	1 0 60	0 0 135	1 0 50	34 0 1305	21.7 0

a. 26.1
b. 1405

SPU

Experiment 3

1 1	400	40 1 470	6 1 150	15 0 110	20 0 100	40 0 210	8 1 100	10 0 130	18 0 80	24 0 100	17 0 1850	19.8 3
1 2	130	40 0 380	6 0 100	17 0 125	20 0 100	40 0 100	10 0 120	11 0 91	23 0 50	28 0 60	14 0 1256	20.9 0
1 3	130	27 0 341	9 0 130	12 0 125	20 0 100	40 0 150	5 0 90	15 0 92	25 0 52	27 0 68	14 0 1278	19.4 0
1 4	130	27 0 418	2 1 145	15 0 130	20 0 100	40 0 175	5 1 100	13 0 93	34 1 54	27 0 76	20 0 1421	20.3 3
1 5	130	40 0 220	20 0 120	15 0 125	25 0 100	40 0 150	20 0 110	18 0 50	34 0 51	34 0 76	21 0 1132	26.7 0
1 6	130	30 0 209	21 0 130	15 0 130	25 0 100	40 0 100	20 0 145	13 0 55	34 0 53	34 0 84	26 0 1136	25.8 0
1 7	130	35 0 242	18 0 130	15 0 130	25 0 100	40 0 130	20 0 135	16 0 60	34 0 55	34 0 140	26 0 1252	26.3 0
1 8	130	35 0 154	26 0 144	15 0 130	28 0 100	40 0 130	2 0 140	7 0 64	34 0 57	34 0 140	32 0 1189	25.3 0
1 9	130	40 0 165	25 0 144	0 0 135	27 0 100	40 0 130	1 0 160	10 0 64	34 0 60	34 0 148	32 0 1236	24.3 0
1 10	140	40 0 154	26 0 144	10 0 135	27 0 130	40 0 140	1 0 140	16 0 70	34 0 80	34 0 148	28 0 1281	25.6 0
2 1	130	40 0 154	26 0 140	10 0 135	27 0 100	30 0 140	20 0 140	15 0 70	34 0 52	34 0 156	25 0 1217	26.1 0
2 2	130	40 0 132	28 0 140	10 0 135	27 0 100	40 0 140	1 0 140	20 0 70	26 0 60	34 0 156	25 0 1203	25.1 0
2 3	130	40 0 132	28 0 170	10 0 135	27 0 100	40 0 150	1 0 140	10 0 75	0 0 70	34 0 172	25 0 1274	21.5 0
2 4	130	40 0 165	25 0 150	10 0 138	27 0 100	40 0 150	1 0 150	9 0 70	34 0 70	34 0 180	26 1 1303	24.6 1
2 5	130	40 0 165	25 0 145	10 0 138	27 0 130	40 0 150	1 0 140	25 0 71	34 0 70	34 0 172	27 1 1311	26.3 1
3 1	130	40 0 165	25 0 130	20 0 138	27 0 100	40 0 100	1 0 135	25 0 71	34 0 69	34 0 164	26 0 1202	27.2 0
3 2	130	40 0 176	25 0 130	20 0 138	27 0 100	40 0 110	1 0 138	2 0 74	26 0 69	34 0 156	31 0 1221	24.5 0
3 3	140	40 0 165	25 0 130	24 0 138	27 0 100	40 0 130	1 0 140	28 0 76	25 0 75	34 0 164	30 0 1258	27.4 0
3 4	145	40 0 143	25 0 130	24 0 135	27 0 100	40 0 130	1 0 142	34 0 76	25 0 78	30 0 156	30 0 1235	27.6 0
3 5	145	40 0 165	25 0 130	24 0 135	26 0 130	30 0 140	1 0 155	34 0 78	0 0 80	2 0 156	29 0 1314	21.1 0
4 1	0	40 0 165	25 0 130	30 0 135	27 0 0	40 0 130	1 0 135	20 0 78	21 0 80	34 0 156	30 0 1009	26.8 0
4 2	130	40 0 154	25 0 130	30 0 131	27 0 0	40 0 130	1 0 135	24 0 80	0 0 80	34 0 156	32 0 1126	25.3 0
4 3	140	40 0 99	31 0 130	35 0 131	27 0 0	40 0 140	1 0 135	24 0 80	0 0 85	34 0 156	32 0 1096	26.4 0
4 4	140	40 0 121	31 0 130	35 0 131	27 0 0	40 0 140	34 0 140	34 0 82	0 0 85	10 0 164	30 0 1133	28.1 0
4 5	130	40 0 140	29 0 130	35 0 131	27 0 130	40 0 150	0 0 148	30 0 107	0 0 120	1 0 164	29 0 1350	23.1 0
5 1	130	40 0 165	25 0 130	40 0 131	27 0 0	40 0 100	34 0 135	34 0 82	0 0 55	34 0 164	29 0 1097[a]	30.3 0
5 2	130	40 0 154	25 0 130	33 0 131	26 0 0	40 0 100	34 0 150	34 0 85	0 0 60	30 0 164	30 0 1104	29.2 0
5 3	130	38 0 143	27 0 130	29 0 131	24 0 0	40 0 100	34 0 135	34 0 85	0 0 70	30 0 164	28 0 1088	28.4 0
5 4	130	38 0 154	26 0 130	29 0 131	20 0 0	40 0 100	34 0 135	34 0 85	0 0 75	30 0 124	28 0 936[b]	27.9 0
5 5	130	38 0 165	25 0 130	30 0 131	20 0 100	40 0 120	1 0 135	34 0 90	0 0 97	1 0 124	28 0 1222	21.7 0
6 1	130	40 0 165	25 0 130	38 0 131	25 0 0	40 0 100	34 0 135	34 0 90	0 0 50	1 0 124	29 0 1055	26.6 0
6 2	130	40 0 165	25 0 130	40 0 131	25 0 0	40 0 100	34 0 135	34 0 90	0 0 55	10 0 132	27 0 1068	27.5 0
6 3	130	40 0 187	23 0 130	42 0 132	24 0 0	40 0 110	34 0 135	34 0 92	0 0 70	1 0 132	27 0 1118	26.5 0
6 4	130	40 0 176	24 0 200	0 0 132	24 0 0	40 0 110	34 0 135	34 0 92	0 0 85	1 0 140	25 0 1200	22.2 0
6 5	130	40 0 165	25 0 180	0 0 132	24 0 100	40 0 120	1 0 140	34 0 95	0 0 120	1 0 132	28 0 1314	19.3 0

a. 1092
b. 1064

SPU

Experiment 4

1	1	80	20	0	100	14	1	200	10	0	50	10	0	130	4	0	100	28	0	1000	14	1	145	16	0	180	12	0	200	10	0	2185	13.8	2
1	2	50	30	0	150	6	0	150	24	0	1	40	0	80	2	0	100	1	0	50	14	0	85	23	0	156	15	0	200	10	0	1022	16.5	0
1	3	45	40	0	100	10	0	200	19	0	50	5	0	85	2	0	100	1	0	75	14	0	116	20	0	156	15	0	200	10	0	1127	13.6	0
1	4	45	40	0	200	8	0	400	30	0	50	2	0	100	2	0	100	1	1	200	14	0	145	16	1	164	14	1	300	10	1	1704	13.7	4
1	5	40	36	0	150	12	0	300	8	0	25	40	0	80	4	0	100	17	0	200	32	1	145	5	1	196	10	1	200	5	0	1436	16.9	3
1	6	45	29	0	200	9	0	250	6	0	10	40	0	75	4	0	100	34	0	70	29	0	110	10	0	108	21	0	200	5	0	1168	18.7	0
1	7	43	31	0	100	18	0	300	21	0	5	30	0	80	4	0	100	34	0	100	16	0	130	5	0	108	21	0	300	5	0	1266	18.5	0
1	8	40	31	0	350	21	0	400	16	0	50	30	0	82	4	0	100	34	0	300	30	1	125	18	0	108	21	0	300	10	0	1855	21.5	1
1	9	30	30	0	200	19	0	300	8	0	50	40	0	70	5	0	100	34	0	250	5	1	120	20	0	108	21	0	300	10	1	1528	19.2	2
1	10	30	28	0	200	30	0	300	8	0	70	20	0	60	4	0	200	1	0	185	12	0	150	16	0	86	30	0	200	10	0	1481	16.9	0
2	1	35	40	0	200	38	0	300	16	0	50	30	0	80	4	0	50	34	0	180	12	0	120	5	0	20	32	0	200	10	0	1235	22.1	0
2	2	33	40	0	200	36	0	200	31	0	10	40	0	90	4	0	50	34	0	185	12	0	115	4	0	20	32	0	200	10	0	1103	24.3	0
2	3	35	40	0	300	30	0	300	8	0	10	40	0	100	4	0	50	34	0	185	12	1	130	1	1	20	32	0	300	10	1	1430	21.1	3
2	4	39	39	0	200	40	0	300	8	0	100	20	0	95	4	0	100	34	0	185	4	0	120	2	0	20	32	0	200	15	0	1359	19.8	0
3	1	30	40	0	150	36	0	300	27	0	100	20	0	75	5	0	200	17	1	300	34	1	118	1	0	12	33	0	200	15	0	1485	22.8	2
3	2	20	40	0	150	39	0	300	27	0	100	20	0	67	5	0	100	17	0	180	34	0	116	1	0	12	33	0	200	10	0	1245	22.6	0
3	3	25	40	0	200	38	0	300	8	0	100	20	0	90	4	0	100	17	1	200	12	0	118	1	0	12	33	0	300	10	1	1445	18.3	2
3	4	40	40	0	100	32	0	300	27	0	120	20	0	100	5	0	100	17	0	225	8	1	117	1	0	4	33	0	200	20	1	1306	20.3	2
3	5	60	40	0	130	35	0	300	8	0	120	20	0	75	5	0	200	17	0	200	1	0	116	1	0	4	34	0	200	15	0	1405	17.6	0
4	1	40	40	0	150	38	0	400	12	1	120	20	0	75	4	0	100	17	0	175	1	0	115	1	0	4	34	0	200	15	0	1379	18.2	1
4	2	40	40	0	130	40	0	200	28	0	120	20	0	80	5	0	100	17	0	175	1	0	114	1	0	4	34	0	200	15	0	1163	20.1	0
4	3	50	40	0	150	35	0	100	23	0	120	20	0	90	5	0	100	17	0	200	1	0	118	1	0	4	34	0	200	15	0	1132	19.1	0
4	4	80	40	0	100	38	0	300	8	0	120	20	0	120	5	0	50	1	0	225	1	0	120	1	0	4	34	0	300	10	1	1419	15.8	1
4	5	80	40	0	100	39	0	300	8	0	120	20	0	110	5	0	50	1	0	197	1	0	116	2	0	4	34	0	200	15	0	1277	16.5	0
5	1	40	40	0	90	38	0	199	19	0	120	20	0	100	6	0	100	17	0	197	1	0	116	4	0	4	34	0	250	15	0	1216	19.4	0
5	2	40	40	0	70	38	0	150	26	0	150	20	0	200	4	0	100	17	0	225	1	1	118	1	0	4	34	0	250	15	1	1307	19.6	2
5	3	55	40	0	80	38	0	150	16	0	150	10	0	90	4	0	100	17	0	205	1	0	117	1	0	4	34	0	200	15	0	1151	17.6	0
5	4	55.4	40	0	65	30	0	300	8	1	150	10	0	90	5	0	100	17	0	210	1	0	120	1	0	4	34	0	250	10	1	1344	15.6	2
5	5	60	40	0	65	35	0	150	30	0	150	20	0	90	5	0	100	17	0	200	1	0	117	8	0	4	34	0	200	15	0	1136	20.5	0

SPU
Experiment 5

1 1	300	6 0 110	30 0 100	6 0 150	10 0 60	40 0 130	20 0 100	18 0 10	10 0 100	15 0 100	20 0 1160	17.5	0
1 2	500	7 1 121	29 0 150	10 0 250	10 0 60	40 0 130	20 1 110	19 0 13	10 0 200	15 0 120	15 0 1654	17.5	2
1 3	300	4 0 110	30 0 200	10 0 170	10 0 50	40 0 20	34 0 90	20 0 15	15 0 150	15 0 130	10 0 1235	18.8	0
1 4	350	5 0 132	28 0 135	4 0 200	18 0 1	40 0 10	34 0 95	22 0 7	10 0 150	15 0 130	8 0 1210	18.4	0
1 5	300	2 0 143	27 0 170	15 0 200	18 0 50	40 0 10	34 0 130	22 0 63	10 0 160	15 0 130	5 0 1356	18.8	0
2 1	400	7 0 143	27 0 100	10 0 200	10 0 35	40 0 10	34 0 90	22 0 13	10 0 160	18 0 130	1 0 1281	17.9	0
2 2	500	6 1 143	27 0 50	5 0 200	13 0 20	4 0 10	34 1 95	25 0 7	10 0 160	15 0 130	1 0 1315	14	2
2 3	700	2 1 143	27 0 300	25 1 200	13 0 5	40 0 10	34 0 100	26 0 13	10 0 160	15 0 130	2 0 1761	19.4	2
2 4	200	7 0 143	27 0 150	5 0 150	13 0 5	40 0 10	34 0 4	34 0 7	10 0 160	18 0 130	1 0 959	18.9	0
2 5	700	10 1 176	24 0 150	6 0 200	13 0 5	40 0 10	34 0 95	34 0 10	10 0 160	18 0 130	1 0 1636	19	1
3 1	100	5 0 165	25 0 30	15 0 200	15 0 5	40 0 10	34 0 4	34 0 7	10 0 160	18 0 130	1 0 811	19.7	0
3 2	200	7 0 363	7 0 70	5 0 250	15 0 5	40 0 10	34 0 4	34 0 10	10 0 160	18 0 130	1 0 1202	17.1	0
3 3	200	10 0 407	3 1 100	4.5 0 300	15 1 5	40 0 10	34 0 4	34 0 13	10 0 160	18 0 130	1 0 1329	17	2
3 4	200	10 0 275	15 0 100	5 0 200	13 0 5	40 0 10	34 0 4	34 0 13	10 0 160	18 0 130	2 0 1097	18.1	0
3 5	200	10 0 363	7 0 150	6 0 250	13 0 5	40 0 10	34 0 4	34 0 13	10 0 160	34 0 130	2 0 1285	19	0
4 1	250	10 0 407	3 0 100	1 0 275	13 0 5	40 0 10	34 0 50	34 0 13	10 0 2000	33 1 130	1 0 3240	17.9	1
4 2	200	10 0 385	5 0 120	6 0 200	13 0 5	40 0 10	34 0 50	34 0 10	7 0 160	15 0 130	2 0 1270	16.6	0
4 3	100	12 0 396	4 0 100	5 0 225	13 0 5	40 0 10	34 0 25	34 0 13	7 0 160	34 0 130	3 0 1164	18[a]	0
4 4	200	12 0 429	1 1 50	3 0 300	13 0 5	40 0 10	34 0 50	34 0 10	7 0 160	34 0 130	3 0 1344	18.1	1
4 5	200	11 0 418	2 0 60	4 0 225	10 0 5	40 0 10	34 0 50	34 0 10	7 0 160	34 0 130	2 0 1268	17.8	0
5 1	100	12 0 429	1 0 100	4 0 225	10 0 5	40 0 10	34 0 4	34 0 7	10 0 160	34 0 130	3 0 1170	18.2	0
5 2	100	12 0 429	1 1 200	5 0 300	10 0 5	40 0 10	34 0 20	34 0 1	5 0 160	34 0 130	3 0 1355	17.8	1
5 3	100	12 0 407	1 0 100	5 0 200	15 0 5	40 0 10	34 0 20	34 0 10	10 0 160	34 0 130	3 0 1142	18.8	0
5 4	150	12 0 429	1 1 200	3 0 250	19 0 5	40 0 10	34 0 10	34 0 10	13 0 160	18 0 130	5 0 1354	17.9	1
5 5	150	10 0 209	21 0 175	4 0 230	19 0 5	40 0 10	34 0 50	34 0 10	15 0 160	18 0 130	5 0 1129	20	0

a. 18.6

SPU
Experiment 6

1 1	100	17 0 130	30 0 100	5 0 100	10 0 100	10 0 50	28 0 200	2 0 150	11 0 200	15 0 76	20 0 1206	14.8	0
1 2	90	19 0 130	30 1 100	5 1 100	20 0 100	14 0 100	22 0 300	14 1 159	11 1 180	15 0 116	20 0 1366	17	4
1 3	85.5	32 0 130	40 0 95	7 0 100	25 0 100	15 0 100	30 0 250	17 1 300	4 1 200	15 1 116	20 0 1476	20.5	3
1 4	75.2	33 0 120	40 0 95	15 0 50	30 0 10	20 0 50	35 0 150	18 0 50	34 0 50	15 0 108	20 0 758	26	0
1 5	75.2	33 0 150	40 0 95	16 0 100	30 0 50	20 0 50	20 0 200	8 0 75	30 0 70	15 0 76	10 0 911[a]	22.2	0
1 6	90	31 0 150	40 0 100	16 0 100	30 0 80	20 0 0	40 0 200	9 0 65	32 0 100	6 0 92	10 0 977	23.4	0
1 7	90	31 0 150	40 0 100	16 0 150	30 0 100	0 0 50	30 0 250	15 0 125	2 0 50	15 0 92	1 0 1157	18	0
1 8	98	31 0 130	40 0 105	16 0 150	30 0 120	5 0 80	30 0 220	25 0 100	10 0 80	15 0 108	1 0 1191	20.3	0
1 9	98	31 0 170	40 0 108	16 0 130	30 0 130	40 0 100	20 0 220	25 1 200	20 1 150	15 1 100	1 0 1406	23.8	3
1 10	90.2	31 0 165	40 0 105	20 0 130	30 0 129	40 0 100	10 0 170	25 0 140	19 0 150	1 0 108	1 0 1287	21.7	0
2 1	91	31 0 130	40 0 105	22 0 120	35 0 130	40 0 0	10 0 175	25 0 140	19 0 150	1 0 108	1 0 1149	22.4	0
2 2	98	31 0 130	40 0 110	25 0 130	35 0 130	40 0 50	0 0 180	25 0 170	17 0 150	5 0 108	1 0 1256	21.9	0
2 3	110	36 0 130	40 0 125	25 0 130	35 0 130	40 0 60	0 0 185	25 0 160	20 0 150	1 0 116	1 0 1296	22.3	0
2 4	110	39 0 130	40 0 128	26 0 130	40 0 131	40 0 65	0 0 185	25 1 160	20 0 160	1 1 117	1 0 1316	23.2	2
2 5	108.9	39 0 130	40 0 128	23 0 130	40 0 132	40 0 80	0 0 175	25 0 160	19 0 100	1 0 117	1 0 1261	22.8	0
3 1	110	39 0 130	40 0 130	25 0 130	40 0 130	40 0 0	40 0 175	23 0 165	18 0 100	1 0 92	1 0 1162	26.7	0
3 2	250	39 1 130	40 0 130	26 0 134	40 0 130	40 0 30	20 0 175	20 0 170	1 0 180	1 1 60	1 0 1389	22.8	2
3 3	120	29 0 130	40 0 130	25 0 130	35 0 130	40 0 50	30 0 176	20 0 155	1 0 100	1 0 92	1 0 1213	22.2	0
3 4	120	29 0 140	40 0 130	25 0 130	40 0 130	40 0 60	30 0 177	21 1 175	1 0 180	26 1 100	1 0 1342	25.3	2
3 5	110	29 0 130	40 0 130	25 0 130	35 0 130	40 0 60	20 0 181	20 0 170	1 0 180	1 0 100	1 0 1311	21.2	0

a. 941.2

SP

Experiment 1

1	1	0	40	200	2	50	20	80	20	50	20	80	11	75	10	130	10	200	1	200	1	1065	13.5
1	2	10	40	300	2	60	25	100	15	50	25	80	11	60	5	80	8	200	0	20	13	960	14.4
1	3	50	40	300	1	40	30	50	10	100	35	100	9	90	22	60	10	50	0	106	13	946	17
1	4	50	40	300	1	80	30	50	5	100	40	110	9	148	16	100	15	100	1	96	5	1134	16.2
1	5	10	40	250	1	20	35	80	8	150	40	120	11	40	29	100	20	100	1	136	1	1006	18.6
1	6	50	40	300	1	30	35	80	5	150	40	130	12	100	12	105	20	100	1	136	1	1181	16.7
1	7	50	40	400	1	40	36	90	5	150	40	130	12	110	12	110	20	100	0	152	1	1332	16.7
2	1	50	40	150	2	20	38	80	5	50	40	130	13	100	17	100	20	50	1	120	1	850	17.7
2	2	0	0	200	2	50	35	90	5	100	17	135	20	100	16	105	20	50	1	149	1	979	11.7
2	3	0	0	200	2	60	34	100	10	150	40	130	12	130	12	110	20	100	20	162	1	1142	15.1
2	4	0	0	250	2	40	36	100	12	130	40	130	12	130	13	120	18	100	25	172	1	1172	15.9
2	5	50	40	250	4	55	37	130	12	132	40	135	12	130	13	130	17	100	25	152	1	1264	20.1
3	1	0	0	200	2	10	40	100	10	100	20	130	12	130	12	120	18	70	20	134	1	994	13.5
3	2	0	0	210	2	20	40	100	15	121	20	135	12	130	13	120	18	120	20	152	1	1108	14.1
3	3	0	0	100	10	30	40	110	15	150	40	135	14	130	13	110	20	0	0	152	1	917	15.3
3	4	100	40	150	11	30	40	120	15	160	40	130	12	130	14	92	23	100	25	152	1	1164	22.1
3	5	100	40	200	11	60	40	150	15	165	40	135	14	130	13	116	20	120	30	152	1	1328	22.4
4	1	0	0	200	11	20	40	100	15	20	20	125	15	130	10	116	20	70	15	130	1	911	14.7
4	2	0	0	200	11	10	40	100	15	150	20	130	18	130	11	91	23	70	10	130	1	1011	14.9
4	3	0	0	200	15	10	40	100	15	150	40	130	18	130	11	101	21	50	0	130	1	1001	16.1
4	4	0	0	200	16	50	40	110	15	100	40	130	18	130	10	100	22	100	25	130	1	1050	18.7
4	5	100	40	180	18	75	40	130	18	150	40	130	14	130	6	105	21	1	25	130	1	1131	22.3
5	1	0	0	200	18	100	40	100	20	176	40	135	12	130	6	130	18	50	10	130	1	1151	16.5
5	2	0	0	90	20	130	40	100	20	176	30	135	12	130	7	130	18	100	10	130	1	1121	15.8
5	3	50	0	150	20	50	40	110	20	100	40	130	12	130	7	130	18	120	0	130	1	1100	15.8
5	4	50	10	180	18	50	40	120	20	150	40	130	12	130	7	130	18	125	20	130	1	1195	18.6
5	5	110	40	200	20	65	40	150	25	160	40	130	10	130	5	130	18	135	25	136	1	1346	22.4

SP

Experiment 2

1	1	130	26	50	7	100	20	90	18	88	32	200	34	100	13	25	15	100	34	66	6	949	20.5
1	2	150	26	20	10	150	16	85	18	99	31	300	34	100	14	30	15	110	30	20	3	1064	19.7
1	3	130	26	20	10	130	27	90	18	99	31	300	10	130	14	30	15	120	25	30	17	1069[a]	19.6[b]
1	4	200	30	17	15	150	30	95	18	110	30	500	10	150	26	35	15	130	18	20	20	1407	21.2
2	1	180	30	12	20	90	27	80	23	110	30	100	4	140	34	10	15	100	18	27	25	849	22.6
2	2	200	25	20	10	100	5	80	23	110	30	150	4	126	34	15	15	100	5	27	20	928	17.1
2	3	180	25	25	10	110	30	85	23	110	30	150	5	128	34	15	15	100	8	150	22	1053	20.2
2	4	200	35	23	12	110	35	95	23	99	31	150	10	130	34	20	16	50	34	250	20	1127	25
2	5	200	30	23	15	130	30	95	23	99	31	200	10	140	34	30	16	100	18	300	20	1317	22.7
3	1	200	28	22	13	40	40	85	26	99	31	50	1	100	34	15	16	100	18	10	10	721	21.7
3	2	200	25	20	17	70	40	85	26	110	30	50	1	128	15	30	18	100	18	50	20	843	21
3	3	200	25	23	17	75	1	85	26	110	30	75	1	129	18	30	18	100	10	50	30	879	17.6
3	4	220	25	30	15	95	5	100	29	110	30	75	1	129	20	40	25	80	10	50	30	929	19
3	5	220	25	30	17	130	40	85	29	99	31	85	1	135	19	40	25	100	10	10	32	934	22.9
4	1	220	25	30	20	80	1	130	30	99	31	85	1	130	20	10	25	120	10	10	15	914	17.8
4	2	220	20	30	20	90	1	100	30	99	31	100	1	130	18	10	25	20	10	5	15	804	17.1
4	3	250	17	33	20	90	1	50	40	110	30	100	1	70	20	50	17	100	10	20	15	873	17.1
4	4	250	17	40	20	100	1	65	40	110	30	125	1	100	17	80	17	136	10	10	17	1016	17
4	5	250	17	45	20	140	40	80	40	99	31	130	1	128	22	90	17	130	1	10	17	1102	20.6
5	1	275	15	45	20	100	40	50	39	99	31	130	1	10	22	100	17	140	1	10	15	959	20.1
5	2	220	20	45	20	110	1	50	39	99	31	150	1	80	19	100	16	40	34	10	15	904	19.6
5	3	231	19	50	20	115	20	50	39	99	31	160	1	99	19	105	15	100	18	10	17	1019	19.9
5	4	240	30	55	30	130	40	60	39	99	31	160	1	110	20	110	14	110	18	10	25	1084	24.8
5	5	261	16	60	35	140	40	90	39	99	31	160	1	128	20	130	6	140	1	10	25	1218	21.4
6	1	260	10	40	20	100	1	50	18	99	31	160	1	128	20	150	4	0	34	10	27	997	16.6
6	2	275	10	50	20	130	1	50	18	99	31	165	1	128	20	140	4	20	34	10	30	1067	16.9
6	3	10	40	60	20	120	1	80	40	99	31	170	1	130	20	140	2	50	34	10	30	869	21.9
6	4	260	16	70	20	130	10	50	18	99	31	170	1	130	20	140	1	110	18	10	27	1169	16.2
6	5	300	16	80	20	150	40	75	40	99	31	170	1	130	20	142	1	120	18	10	27	1276	21.4
7	1	10	40	60	20	130	20	50	18	99	31	170	1	130	20	145	1	0	34	10	27	804	21.2
7	2	10	40	80	20	130	10	50	18	99	31	10	1	130	20	135	1	120	1	10	27	774	16.9
7	3	130	28	90	15	130	10	50	18	110	30	50	1	130	20	10	33	100	4	10	27	810	18.6
7	4	220	20	100	15	100	1	50	18	110	30	45	1	130	20	136	1	110	4	10	27	1011	13.7
7	5	300	12	100	15	150	40	130	40	110	30	150	1	130	13	143	1	148	1	10	27	1371	18

a. 1079

b. 19.3

SP

Experiment 3

1	1	95	10	39	40	100	11	200	20	110	15	84	22	1	34	180	30	75	10	125	22	1009	21.4
1	2	75	6	17	40	50	2	100	15	130	12	80	7	1	34	130	30	125	15	160	13	868	17.4
1	3	110	2	200	2	200	1	100	10	150	9	160	1	1	34	200	22	200	20	175	10	1496	11.1
2	1	90	3	300	27	300	1	150	15	145	14	140	3	1	34	130	20	150	15	160	11	1566	14.3
3	1	75	5	170	37	200	1	100	20	143	17	200	1	1	34	120	22	125	13	170	10	1304	16
4	1	85	6	70	35	200	1	150	15	147	11	195	5	1	34	120	22	140	14	170	8	1278	15.1
4	2	80	6	700	7	400	4	100	15	155	16	170	4	1	34	50	25	140	14	160	10	1956	13.5
5	1	40	7	400	2	1000	10	150	15	180	12	180	4	1	34	50	30	200	20	160	8	2361	14.2

SP

Experiment 4

1	1	90	39	150	15	75	20	50	40	251	40	150	16	50	12	80	8	250	20	240	9	1386	21.9
2	1	80	39	155	10	50	40	15	32	10	40	120	8	40	12	85	10	52	1	119	18	726	21
2	2	70	39	130	20	150	20	100	19	1	40	120	9	20	12	85	10	250	34	170	14	1096	21.7
2	3	70	39	125	1	130	40	150	23	5	40	140	13	20	12	160	22	250	15	200	7	1250	21.2
2	4	60	39	300	1	130	2	100	24	1	40	160	17	20	12	180	21.6	275	20	260	4	1486	18.1
3	1	60	40	50	40	100	30	100	25	2	39	150	17	20	12	140	21.4	300	5	100	14	1022	24.3
3	2	70	40	50	20	130	20	150	27	1	40	200	17	30	34	160	21.5	250	5	150	18	1191	24.2
3	3	80	40	50	20	100	40	150	29	.5	40	200	15	10	10	165	18.6	100	25	240	17	1095	25.5
3	4	80	38	50	40	100	40	150	18	.25	40	200	15	20	20	120	21.5	275	25	240	18	1235	27.6
3	5	50	40	50	40	75	40	100	18	.25	40	170	20	20	20	160	22.6	300	5	250	34	1175	28

SP

Experiment 5

1	1	280	20	175	15	200	10	125	14	10	40	78	8	300	34	100	23	150	11	200	9	1618	18.4
2	1	150	18	150	16	300	25	90	21	8	40	250	16	50	20	50	15	180	18	250	10	1478	19.9
3	1	250	19	175	20	200	20	52	25	10	40	85	34	10	34	50	18	130	9	200	10	1162	22.9
3	2	200	18	175	15	400	35	65	30	8	40	85	34	100	34	50	18	140	10	200	10	1423	24.4
4	1	285	19	175	17	200	20	50	40	50	40	70	32	100	34	30	12	160	19	150	10	1270	24.3
4	2	200	19	175	17	200	20	60	26	1	40	60	33	30	34	20	10	160	19	100	10	1006	23.4[a]
4	3	120	13	175	17	200	5	67	22	50	40	60	33	130	34	35	10	160	8	150	10	1147	19.2
4	4	100	12	175	17	200	1	88	9	10	40	60	33	130	34	30	12	160	8	150	10	1103	17.6
4	5	125	12	170	17	200	1	85	16	88	40	75	33	130	34	40	12	170	8	150	10	1233	18.3
5	1	200	15	175	17	300	15	85	10	1	40	85	33	130	34	35	12	160	19	100	10	1271	20.5
5	2	300	18	175	17	300	25	79	13	1	40	100	33	130	34	20	12	170	8	100	10	1375	21

a. 22.8

SP
Experiment 6

1	1	100	1	0	40	75	13	50	35	150	9	120	5	100	12	200	20	110	12	50	10	955	15.7
1	2	10	40	0	40	100	13	100	31	150	10	130	1	150	12	100	20	120	12	50	10	910	18.9
1	3	10	40	30	40	110	13	130	28	200	10	132	1	150	12	100	15	130	14	50	9	1042	18.2
1	4	10	40	60	40	150	20	130	28	200	10	132	1	150	12	100	20	130	14	75	10	1137	19.5
1	5	10	40	60	40	200	30	130	28	200	15	130	1	150	12	100	20	130	12	100	17	1210	21.5
1	6	5	40	60	40	150	40	140	27	250	10	120	1	150	15	200	1	120	12	200	20	1395	20.6
2	1	5	40	0	40	150	15	100	40	250	6	120	5	100	20	200	25	110	12	30	20	1065	22.3
2	2	5	40	0	40	200	20	110	40	275	25	130	1	110	18	10	25	120	15	30	20	990	24.4
2	3	5	40	30	40	100	25	120	40	250	15	149	1	110	20	100	25	130	18	40	30	1034	25.4
2	4	5	40	60	40	150	23	130	40	300	15	150	1	100	25	100	34	100	18	50	21	1145	25.7
2	5	1	40	70	40	222	31	165	20	350	20	160	1	100	25	200	15	110	20	50	20	1428	23.2
3	1	1	40	0	40	100	20	160	40	200	20	100	1	150	15	0	20	110	20	25	15	846	23.1
3	2	1	40	50	40	111	29	160	40	100	20	90	1	50	25	0	20	110	20	30	15	702	25
3	3	1	40	50	40	199	28	160	40	100	20	90	1	100	25	0	25	120	20	25	25	845	26.4
3	4	10	40	70	40	252	26	160	40	100	25	130	1	100	20	0	20	120	22	25	25	967	25.9
3	5	0	40	30	40	300	30	50	40	100	20	160	1	50	20	0	25	135	17	50	20	875	25.3
4	1	10	40	100	40	300	25	160	40	100	25	154.8	1	150	15	0	20	120	17	25	15	1120	23.8
4	2	0	40	50	40	293	17	50	40	100	25	150	1	100	20	500	20	115	18	25	15	1383	23.6
5	1	10	40	100	40	123	13	130	40	100	25	10	1	150	25	0	20	110	18	25	15	758	23.7
5	2	10	40	100	40	201	17	160	40	100	25	10	34	75	30	0	20	115	18	25	15	796	27.9
5	3	0	40	100	40	10	20	130	40	100	25	50	34	50	30	1300	34	115	18	25	15	1880	29.6

DCU
Experiment 1

1	1	30	0 554.4	1 60	0 10	0 41.8	0 102.4	0 50	1 200	1 10	0 5.5	0 8.2	3
1	2	60	1 .1	1 95	0 10	0 37.4	0 102.4	0 100	1 525	1 7	1 17.5	0 7.34	5
1	3	20	1 .1	0 95	1 10.4	1 33	1 78	1 30	1 50	1 15	1 52	0 2.95	8
1	4	80	1 .1	0 30	0 8	1 36.3	0 126	1 120	1 75	0 20	1 60	0 4.27	5
1	5	39	1 .5	0 30	0 10	1 35.2	1 102.4	1 10	0 150	1 50	1 27.1	0 3.5	6
1	6	50	1 .1	0 30	0 13	1 7.7	1 102.4	1 5	0 200	1 15	1 37.5	0 3.5	6
1	7	10	0 .1	0 300	1 50	0 36.3	0 78	0 7.5	0 75	0 5	0 500	1 7.8[a]	2
1	8	10	1 .1	0 30	0 10	1 36.3	0 78	1 6	1 75	1 7	1 10.5	0 2	6
1	9	100	1 .1	0 40	0 8.5	1 36.3	1 52.8	0 20	1 100	1 100	1 6	0 3.6	6
1	10	10	0 .1	0 30	0 1	1 35	0 126	1 10	1 80	1 5	0 10	0 2.4	4
2	1	30	1 .1	0 60	1 10	1 40	0 52.8	0 50	1 75	1 7	0 6	1 2.6	6
2	2	60	1 .1	0 30	0 2.5	0 25	0 52.8	1 2	0 20	0 50	1 12.9	0 2	3
2	3	50	1 .1	0 30	0 6	1 40	0 50	1 7.5	1 10	0 10	0 16.2	0 1.7	4
2	4	150	1 .1	0 30	0 5	0 30	0 1	0 4	1 10	0 20	0 11.1	0 2	2
2	5	26	0 .1	0 30	0 5	1 50	0 1	0 1	1 10	0 15	0 21.2	0 1.2	2
3	1	100	0 .1	0 30	0 5	0 100	0 10	0 7.5	0 405	1 5	0 7.5	0 5.2	1
3	2	120	1 .1	0 30	0 10	0 60	0 10	0 2	1 10	0 5	0 15	0 2	2
3	3	130	1 .1	0 30	0 7	0 40	0 100	1 1.5	0 12.5	0 10	0 22.5	1 2.7	3
3	4	130	0 .1	0 30	0 5	0 40	0 10	0 7.5	0 20	0 300	1 30	0 4.4	1
3	5	140	1 .1	0 40	0 7.5	1 40	0 30	0 5	0 20.5	0 5	0 11	0 2.3	2
4	1	5	1 .1	0 30	1 10	1 30	1 1.3	0 5	1 30	1 20	0 2.5	0 1	6
4	2	100	0 .1	0 30	0 8	0 900	1 5	0 .5	0 75	0 5	0 6.9	0 8.7	1
4	3	150	1 .1	0 30	0 8	1 70	1 5	0 1	0 70	1 13	0 9.5	0 2.7	4
4	4	200	1 .1	0 30	0 5	0 60	0 50	0 1.5	.0 75	0 130	1 11	1 4.3	3
4	5	5	0 .1	0 30	1 5	0 45	0 50	1 1	1 50	1 5	0 11.9	0 1.6	4

a. 8.2

DCU
Experiment 2

1 1	111	0 68	1 20	0 40	0 50	0 230	1 5	0 800	1 400	1 65	0 13.8	4
1 2	84.3	1 4	1 16	0 40	0 80	1 60	1 10	0 2	0 5	0 45	0 2.7	4
1 3	843.9	1 44	1 15	0 69	0 70	0 200	1 15	0 4	0 5	0 30	0 9.9	3
1 4	20.3	0 83	1 15	0 110	0 99	0 600	1 50	0 5	0 3	0 25	0 7.8	2
1 5	18.2	0 64	1 15	0 103	0 50	1 8	0 50	0 4	1 2	0 20	0 2.6	3
1 6	12.1	0 50	1 3	0 500	1 99	1 6	0 50	0 3	0 1	0 10	0 5.7	3
1 7	5.5	1 68	1 2	0 207	1 99	1 5	0 100	1 7	0 1	0 5	0 3.8	5
1 8	11.1	0 77	1 1	0 94	0 79	1 4	0 50	1 1	0 6	0 3	0 2.5	3
1 9	16.9	1 37	1 1	0 49	0 10	1 2	1 50	1 5	1 0	0 2	0 1.3	6
1 10	13	0 44	0 15	0 71	0 99	0 6	0 50	0 10	1 5	0 1	0 2.4	1
2 1	101	1 99	1 15	0 88	0 99	1 52	1 50	0 6	0 50	0 1	0 4.3	4
2 2	20.8	0 31	1 10	0 67	0 80	1 3	0 100	1 30	0 3	0 1	0 2.7	3
2 3	50	1 39	1 6	0 50	0 90	1 2	0 50	0 6	0 10	0 3	0 2.4	3
2 4	8.5	0 69	1 27	0 100	0 93	1 16	0 10	0 1	0 4	0 4	0 2.6	2
2 5	13.7	0 20	1 1	0 45	0 99	0 8	0 50	0 4	0 5	0 4	0 1.9	1
3 1	20.1	0 37	0 2	0 55	0 99	1 900	1 50	0 8	0 5	0 4	0 9.1	2
3 2	21.1	0 37	1 10	0 77	0 90	1 2	0 50	0 9	1 20	0 4	0 3.5	3
3 3	18.4	0 17	0 12	0 99	0 99	0 4	0 100	0 6	0 99	0 2	0 3.5	0
4 1	20.1	0 7	0 100	1 89	0 50	1 6	0 50	0 6	0 25	0 2	0 2.7	2
4 2	13	0 13	1 30	0 100	1 10	1 2	0 78	1 9	1 5	0 2	0 2	5
4 3	12.8	1 9	1 2	0 77	1 5	0 10	0 50	1 5	1 10	0 4	0 1.4	5
4 4	20.1	0 11	0 50	0 120	0 10	0 4	0 90	0 4	0 80	1 5	0 3	1
4 5	7.7	0 11	0 50	0 99	1 30	0 4	0 75	0 4	0 2	0 5	0 2.2	1

DCU
Experiment 3

1 1	0	1 3	0 60	0 50	0 40	1 50	0 80	0 80	1 40	0 70	1 3.6	6
1 2	90	1 1	0 40	0 70	0 20	0 80	0 85	0 40	0 50	0 200	1 5.2	2
1 3	210	1 1	0 70	0 75	1 10	0 90	1 83	0 20	0 60	0 10	0 4.8	3
1 4	858	1 1	0 30	0 70	0 5	0 20	0 85	0 30	0 50	0 15	0 9	1
1 5	1200	1 1	0 20	0 70	0 5	0 20	0 80	0 10	0 70	0 5	0 11.4	1
1 6	5200	1 1	0 20	0 70	0 5	0 20	0 75	0 50	0 60	0 4	0 42.3	1
1 7	0	1 1	0 25	0 70	1 5	1 20	1 90	1 10	1 50	1 3	1 2.1	8
1 8	858	1 5	0 35	0 70	0 5	0 20	0 86	0 60	1 60	0 1	0 9.2	2
1 9	0	0 1	0 40	0 60	1 5	1 20	1 76	1 20	1 70	1 100	1 3	7
1 10	0	0 10	0 25	0 70	0 5	0 20	1 86	0 50	1 40	0 4	0 2.4	2
2 1	858	1 10	0 29	0 75	0 10	0 20	0 78	0 10	0 60	0 462	1 12.4	2
2 2	858	1 10	0 32	0 75	1 5	0 10	0 84	0 20	0 60	0 50	0 9.3	2
2 3	858	1 50	0 26	0 70	0 5	0 10	0 70	0 30	0 60	0 40	0 9.4	1
2 4	390	1 50	0 19	0 75	1 5	1 10	0 77	0 40	0 60	0 40	0 5.9	3
2 5	0	0 50	0 15	0 80	0 10	0 10	1 80	0 10	0 60	1 30	0 2.7	2
3 1	858	1 10	0 18	0 60	0 10	0 10	0 70	0 25	0 50	0 0	0 8.5	1
3 2	390	1 10	0 25	0 75	0 5	0 10	0 75	0 10	0 50	0 0	0 5	1
3 3	390	1 10	0 30	0 75	0 7	0 10	0 80	0 30	0 50	0 0	0 5.2	1
3 4	30	0 10	0 22	0 70	1 5	1 10	1 72	0 2	1 70	1 0	0 2.2	5
3 5	30	0 1	0 25	0 70	0 5	0 10	1 85	0 60	1 30	0 10	0 2.5	2
4 1	390	1 10	0 20	0 90	1 50	0 10	0 85	0 1	0 50	0 100	1 6.2	3
4 2	390	1 10	0 28	0 70	1 25	0 10	0 89	0 5	0 50	0 50	0 5.6	2
4 3	390	1 10	0 27	0 80	1 5	0 10	0 82	0 50	1 50	0 40	0 5.7	3
4 4	390	1 25	0 19	0 75	1 5	0 10	0 80	0 1	0 30	0 30	0 5.1	2
4 5	30	0 1	0 20	0 90	0 5	0 10	1 70	0 2	0 30	0 35	0 2.3	1

DCU
Experiment 4

1 1	0	0 200	1 1	0 40	1 100	0 47	1 234	1 50	0 25	0 260	1 8.8	5
1 2	0	0 300	1 8	0 100	0 85	0 61	0 130	1 60	0 15	0 180	1 7.2	4
1 3	0	0 250	1 8	0 150	0 85	0 110	1 0	0 70	0 15	0 150	1 6.4	3
1 4	0	0 250	1 8	0 150	1 85	0 120	0 13	0 80	0 5	0 150	1 6.6	3
1 5	100	0 250	1 88	0 100	0 100	0 169	0 13	0 80	0 5	0 400	1 10	2
1 6	0	0 250	1 88	0 100	0 130	0 220	1 26	0 80	0 5	0 500	1 10.8	3
1 7	0	0 250	1 125	0 75	0 120	0 250	1 13	0 100	0 5	0 800	1 13.4	3
1 8	0	0 200	1 188	0 70	0 120	0 182	1 13	0 120	0 5	0 10	0 7	2
1 9	0	0 130	0 188	0 70	0 200	0 182	0 104	0 80	0 5	0 600	1 12	1
1 10	0	0 130	0 198	0 50	0 80	0 156	1 130	1 0	0 5	0 10	0 5.8	2
2 1	0	0 200	0 18	0 50	0 400	1 221	1 104	0 80	0 5	0 230	1 10	3
2 2	200	0 200	0 35.2	0 60	0 1000	1 221	1 104	0 90	0 5	0 180	0 15.6[a]	2
2 3	150	0 250	0 23	0 1300	1 1000	1 221	0 117	0 130	0 5	0 180	0 25.9	2
2 4	150	0 300	0 818.4	1 60	0 1300	1 221	0 130	0 200	0 5	0 180	0 25.9	2
2 5	100	0 300	0 471.9	0 60	0 200	0 221	0 104	0 250	0 1	0 80	0 13.7	0
3 1	1600	1 300	0 44	0 60	0 130	0 221	0 130	0 150	0 1	0 230.75	0 22.1	1
3 2	0	0 0	1 44	0 60	1 130	0 250	1 130	1 175	1 1	0 10	0 6.2	5
3 3	150	1 0	1 44	0 60	0 130	0 221	1 130	0 130	0 1	1 180	1 8	5
3 4	100	1 0	0 44	0 60	1 250	1 234	1 130	0 100	0 1	1 120	1 8	6
3 5	100	1 0	0 84	0 60	0 40	0 0	0 104	1 50	0 1	0 80	0 4	2
4 1	100	0 0	0 24	0 60	0 1000	1 234	0 130	0 50	0 1	0 230.75	0 14.1	1
4 2	100	0 0	0 24	0 60	0 1300	1 234	0 130	0 100	0 1	0 200	0 16.5	1
4 3	1500	1 0	0 24	0 60	0 1300	1 234	0 130	0 130	0 1	0 10	0 26.1	2
4 4	1000	1 0	0 48	0 60	0 1300	1 234	0 130	0 200	0 1	0 10	0 22.9	2
4 5	0	0 0	0 4	0 60	0 100	0 234	1 130	0 250	1 1	0 10	0 6.1	2
5 1	250	0 0	0 250	0 200	0 250	0 250	0 240	0 200	0 250	0 250	0 16.5	0
6 1	0	0 0	0 250	0 250	0 260	0 260	0 260	0 230	0 1	0 260	0 13.6	0

a. 16.1

DCU
Experiment 5

1 1	500	1 858	1 500	0 700	0 858	1 100	0 25	0 10	0 50	0 3	0 27.7	3
1 2	1	0 689.7	1 400	0 670	1 500.5	0 115	0 100	0 10	0 15	0 10	0 19.3	2
1 3	858	1 554.4	0 600	0 650	0 203.5	0 60	0 125	0 0	0 10	0 1	0 23.6	1
1 4	858	1 649	0 500	0 640	0 15.4	0 75	0 150	0 0	0 10	0 1	0 22.3	1
1 5	1	1 42.9	0 700	1 635	1 2.2	0 100	1 175	0 0	1 5	0 1	0 12.8	5
1 6	1	1 42.9	0 650	1 570	1 14.3	0 25	0 160	0 0	0 15	0 1	0 11.4	3
1 7	1	1 42.9	0 580	1 500	1 16.5	0 30	1 150	0 0	0 100	0 1	0 10.9	4
1 8	858	1 42.9	0 525	0 400	0 9.9	0 200	1 170	0 0	0 200	0 1	0 18.5	2
1 9	1	0 42.9	0 627	1 450	1 8.8	0 30	0 200	0 0	0 150	0 1	0 11.6	2
1 10	1	0 42.9	0 530	1 400	0 15.4	0 70	0 175	0 0	0 175	0 1	0 10.8	1
2 1	1	0 42.9	0 500	1 400	0 15.4	0 400	1 170	0 0	0 150	0 5	0 13	2
2 2	1	0 42.9	0 649	1 430	0 17.6	0 27	0 180	0 462	1 10	0 1	0 14	2
2 3	1	0 42.9	0 800	1 435	0 17.6	0 30	0 200	0 0	0 25	0 1	0 11.9	1
2 4	1	0 42.9	0 528	0 432	1 16.5	0 30	0 190	0 0	0 25	0 1	0 9.7	1
2 5	100	0 42.9	0 520	1 350	0 20.9	0 30	0 190	0 0	0 25	0 100	0 10.6	1
3 1	858	1 42.9	0 400	0 350	0 15.4	0 200	0 190	0 0	0 25	0 1	0 16	1
3 2	1	0 50	0 400	1 400	1 15.4	0 100	0 190	0 0	0 25	0 1	0 9.1	2
3 3	1	0 42.9	0 450	0 350	1 15.4	0 50	0 190	0 0	0 2	0 1	0 8.5	1
3 4	1	0 42	0 500	1 332	1 14.3	0 30	0 1	0 0	0 1	0 1	0 7.1	2
3 5	1	0 18	0 525	0 200	0 16.5	0 31	0 160	0 0	0 300	0 1	0 9.6	0
4 1	1	0 20	0 500	0 540	0 15.4	0 100	0 150	0 0	0 25	0 10	0 10.5	0
4 2	1	0 20	0 450	0 390	0 15.4	0 100	0 150	0 0	0 25	0 10	0 8.9	0
4 3	1	0 10	0 500	0 160	0 15.4	0 200	0 150	0 0	0 25	0 12.5	0 8.3	0

DCU

Experiment 6

1 1	0	0 364	1 5	0 100	1 20	0 30	0 50	1 65	0 50	1 10	0 5.3	3
1 2	100	0 364	1 10	0 30	1 10	0 30	0 20	1 52	0 30	1 13	1 5.1	5
1 3	0	0 0	0 15	0 0	1 10	0 35	0 200	1 39	0 30	1 50	1 2.9	4
1 4	0	0 26	0 100	1 0	1 10	0 50	0 10	1 39	0 20	1 60	1 2.4	5
1 5	0	0 65	1 10	0 40	1 20	0 60	0 5	1 52	1 25	1 75	1 2.7	6
1 6	0	0 30	0 0	0 130	1 20	0 80	0 300	1 78	0 20	0 45	1 5.4	3
1 7	0	0 40	0 5	0 130	1 30	0 100	1 1	1 130	1 20	1 55	1 3.9	6
1 8	200	1 50	0 50	0 130	1 16	0 100	0 1	0 100	0 20	0 65	1 5.6	3
1 9	0	0 70	0 200	1 75	0 10	0 130	1 1	0 100	0 20	0 30	0 4.9	2
1 10	0	0 65	0 10	0 50	0 10	0 130	1 1	0 200	1 20	0 35	0 4	2
2 1	1000	1 50	0 10	0 50	0 20	0 150	0 300	1 65	0 10	0 49	0 13.1	2
2 2	0	0 170	0 10	0 150	1 30	0 150	1 1	0 130	0 10	0 39	0 5.3[a]	2
2 3	65	0 70	0 10	0 50	0 10	0 150	1 1	0 91	0 15	1 89	1 4.2	3
2 4	52	0 60	0 150	1 0	0 40	0 150	1 1	0 260	1 15	0 47	0 6	3
2 5	30	0 70	0 0	0 60	0 50	0 150	1 1	0 260	1 15	0 36	0 5.2	2
3 1	130	0 70	0 0	0 130	0 40	0 200	1 1	0 260	1 10	0 44	0 6.8	2
3 2	150	0 80	0 0	0 130	1 30	0 150	1 1	0 88	0 10	0 42	0 5.3	2
3 3	0	0 70	0 0	0 100	1 60	0 150	1 1	0 88	0 15	1 57	1 4.2	4
3 4	100	0 70	0 0	0 100	1 10	0 100	0 1	0 88	0 10	1 36	1 4	3
3 5	0	0 50	0 0	0 100	0 50	0 100	1 1	0 88	0 15	0 52	1 3.5	2
4 1	200	0 45	0 0	0 0	0 50	0 300	1 300	1 60	0 10	0 75	0 8.3	2
4 2	260	1 70	0 0	0 50	0 50	0 180	1 1	0 65	0 15	0 69	1 5.8	3
4 3	130	0 70	0 0	0 100	0 50	0 100	0 1	0 107	0 10	0 65	1 4.9	1
4 4	100	0 70	0 0	0 100	1 50	0 100	0 1	0 72	0 10	0 100	1 4.6	2
4 5	0	0 70	0 0	0 100	0 10	0 100	1 1	0 78	0 15	1 49	1 3.3	3
5 1	300	0 364	0 360	0 360	0 320	0 230	0 234	0 232	0 200	0 200	0 21.5	0
5 2	350	0 364	0 300	0 360	0 320	0 230	0 234	0 232	0 180	0 150	0 20.9	0
5 3	300	0 364	0 300	0 360	0 320	0 230	0 234	0 232	0 220	0 200	0 21.2	0

a. 5.2

DC

Experiment 1

1 1	260	0	200	200	0	0	0	130	160	40	7.6
1 2	0	20	100	200	0	0	0	260	155	70	6.2
1 3	0	20	80	0	0	100	0	0	95	60	2.7
1 4	130	10	35	0	0	0	0	0	30	40	1.9
1 5	0	0	20	0	0	0	0	66	25	20	1

DC

Experiment 2

1 1	0	10	20	0	49	0	25	130	100	26	2.8
1 2	0	20	40	0	50	0	25	50	50	52	2.2
1 3	0	20	0	0	30	0	15	25	20	26	1
1 4	0	25	0	0	115	0	0	0	15	0	1.2
1 5	0	25	13	0	300	0	0	12	10	26	3
1 6	50	25	15	50	1	0	0	27	10	0	1.4
1 7	0	25	0	0	200	0	0	24	5	26	2.2
1 8	0	25	10	0	0	0	0	22	10	0	.5
1 9	0	25	0	0	150	0	0	20	5	10	1.6

DC
Experiment 3

1	1	1000	240	1	200	100	700	384	3	25	10	20.5
1	2	75	190	1	200	200	150	4	3	1	0	6.3
1	3	57	140	1	200	100	20	2	3	2	1	4
1	4	13	10	1	200	20	33	1	3	1	1	2.2
1	5	5	40	0	40	10	25	1	1	0	1	.9

DC
Experiment 4

1	1	182	130	130	165	0	50	130	140	25	75	7.9
1	2	130	140	0	100	130	50	230	78	50	50	7.4
1	3	210	200	0	80	0	60	150	34	10	35	6
1	4	96	175	88	100	0	100	130	50	100	38	6.7
1	5	130	175	96	50	0	0	130	65	50	30	5.6

DC
Experiment 5

1	1	760	0	43	40	708	5	10	10	22	50	12.7
1	2	42	0	30	40	125	5	12	13	26	150	3.4
1	3	50	0	20	40	43	3	7	5	11	100	2.1
1	4	10	0	20	40	43	1	10	2	5	0	1
1	5	30	0	40	40	1	1	5	8	4	0	1
1	6	20	0	40	40	0	0	15	11	3	100	1.8
1	7	20	0	40	40	0	0	17	9	2	100	1.8

DC
Experiment 6

1	1	100	200	130	50	300	50	169	75	0	130	9.3
1	2	200	260	200	100	150	60	104	150	0	100	10.2
1	3	100	130	200	75	50	65	104	125	0	100	7.3
1	4	100	100	150	40	50	60	65	120	0	0	5.3
1	5	100	50	200	150	150	55	52	100	0	0	6.6
1	6	100	70	250	0	150	50	78	100	0	0	6.1
1	7	200	20	250	10	10	50	78	100	0	0	5.5
1	8	0	30	400	10	10	40	65	75	0	0	4.8
1	9	100	40	390	40	150	30	65	25	0	0	6.5

FOOTNOTES

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1. The rebate is $b_i(1 - 130¢/\sum b_i)$.

2. An exception is experiment 1 of SPU in which we did not explicitly restrict the message spaces.

3. Because of the restricted message spaces there exist perfect Nash equilibria where one or more individuals' messages are at the boundary.

4. The six experiments selected from Isaac, McCue, and Plott (1985) were those that had ten subjects and no violation of rules. These were experiments 1, 2, 3, 4, 7, 8.

5. The rebate does not change the result of the equality test because it is a proportionate transformation of the data.

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